FINAL

BASELINE ECOLOGICAL RISK ASSESSMENT

Upper Animas Mining District

San Juan County, COLORADO

March 2015

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Table of Contents

List of figures

List of tables

Appendices

Appendix 1	pH, hardness, and total plus dissolved metal concentrations measured in surface water samples from the three waterways
Appendix 2	Total metal concentrations measured in bulk sediment samples collected from the Animas River and the two creeks
Appendix 3	Hardness and dissolved metal concentrations measured in pore water samples collected in the field from the Animas River
Appendix 4	Benthic invertebrate tissue residue data collected from the Animas River in September 2014
Appendix 5	Trout-specific hardness-dependent acute toxicity thresholds (DRAFT)
Appendix 6	Known or likely vertebrate species occurrence in San Juan County, CO
Appendix 7	Calculating hardness-specific benchmarks and HQs in surface water samples
Appendix 8	Calculating sample-specific HQs for dissolved metals in pore water samples collected in the field
Appendix 9a	surface water toxicitytesting reportfor the Upper Animas River (October and November 2012)
Appendix 9b	Surface water toxicity testing report for the Upper Animas River (April 2013)
Appendix 10a	Sediment toxicity testing report for the Upper Animas River (December 2012)
Appendix 10b	Sediment toxicity testing report for the Upper Animas River (November 2014)
Appendix 11	Benthic invertebrate community metrics (September 2014)
Appendix 12	ProUCL calculations to derive EPCs for dissolved metals in surface water for aquatic community-level receptors
Appendix 13	ProUCL calculations to derive EPCs for total metals in surface water for wildlife receptors
Appendix 14	ProUCL calculations to derive sediment EPCs for benthic invertebrates and for use in wildlife food chain modeling
Appendix 15	ProUCL calculations to derive EPCs for dissolved metals in field-collected pore water for benthic invertebrates

LIST OF ABBREVIATIONS AND ACRONYMS

Ag	silver
Al	aluminum
As	arsenic
AUF	area use factor
BAV	bioavailability
BB	Bakers Bridge
BERA	baseline ecological risk assessment
Be	beryllium
BCF	bioconcentration factor
BLM	Bureau of Land Management
BW	body weight
CCC	criteria continuous concentration
Cd	cadmium
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and the Environment
CO	Colorado
COPEC	contaminant of potential ecological concern
Cr	chromium
CSM	conceptual site model
CSWB	chronic surface water benchmark
CTE1	central tendency exposure
Cu	copper
DL	detection limit
DW	dry weight
EDD	estimated daily dose
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ER-L	effect range-low
ER-M	Effect Range-Median
EU	exposure unit
Fe	iron
FIR	food ingestion rate
ft	feet
gpm	gallons per minute
HBI	Hilsenhoff Biotic Index
HRW	hard reconstituted water
HQ	hazard quotient
LEL	lowest effect level
LOE	line of evidence
mg/kg	milligrams per kilogram (parts per million)
mg/kg.d	milligrams per kilogram per day
mg/kg bw.d	milligrams per kilogram body weight per day
MMI	Mobile Metal Ions
Mn	manganese

Ni	nickel
NRWQC	national recommended water quality criteria
Pb	lead
PEC	probable effect concentration
PEL	probable effect level
RME	reasonable maximum exposure
ROC	receptor of concern
Se	selenium
SEL	severe effect level
SGC	Sunnyside Gold Corporation
Site	mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton
SLERA	screening-level ecological risk assessment
SMAV	Species Mean Acute Value
SSL	soil screening level
T&E	threatened and endangered
TEC	threshold effect concentration
TEL	threshold effect level
TRV	toxicity reference value
UCL	Upper Confidence Limit
WIR	water ingestion rate
WP	work plan
WQC	water quality criteria
Zn	zinc

EXECUTIVE SUMMARY

ES.1 Introduction

The Animas River flows through the town of Silverton in San Juan County, CO. This waterway is affected by flow, which has come in contact with mineralized material, either naturally or as a result of mining activities, such as through the creation of mine adits. Affected water originates in the upper reaches of the two major tributaries of the Animas River in this area, namely Cement Creek and Mineral Creek, and from other tributaries of the Animas River further upstream of Silverton. The tributaries contain high levels of metals and acidity that are carried downstream to the Animas River. This evaluation did not attempt to separate natural contamination from past mining-related contamination, but assessed the total risk from all sources combined.

The Exposure Units (EUs) evaluated in this Baseline Ecological Risk Assessment (BERA) consist of the following water bodies:

- *The Animas River above mainstem Cement Creek*: this reach of the Animas River covers about two river-miles between sampling locations A60 and A68. All the sampling locations from this reach of the river were combined into a single EU. Location A68 is the furthest downstream in this reach and is located about 1,000 feet (ft) above the confluence with mainstem Cement Creek. Location A56, situated about 1,000 ft above A60 and just upgradient of the Mayflower Mill and the Arrastra Creek, represents regional upstream conditions. Note that this BERA did not consider this location to represent reference conditions because both the surface water and sediment samples collected at A56 carry a persistent contaminant signal which appears to be associated with mining or ore-related sources further upstream in the watershed.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*: this reach of the Animas River covers about one river-mile between the confluences of the two creeks. Location A69A is about 3,000 ft downstream of the confluence with mainstem Cement Creek (just upstream of Idaho Gulch), whereas location A70B is just upstream of the confluence with mainstem Mineral Creek. Both of these sampling locations were combined into one EU.

- *The Animas River below mainstem Mineral Creek*: this reach of the Animas River covers about 30 river-miles between sampling locations A71B, and Bakers Bridge (BB). The following values represent the approximate distance (in river-miles, where appropriate) separating the point where mainstem Mineral Creek enters the Animas River in Silverton and the downstream sampling locations: A71B—around 300 ft, A72—around 3,500 ft, A73/A73B—5.9 miles, A75D/A75B—18.9 miles, and BB—30 miles. Each sampling location on this reach of the river was considered as a distinct EU due to the large distances separating A71B and BB.

- *Mainstem Cement Creek*: the section evaluated in this BERA is represented by sampling locations CC48 and CC49 found on the creek within one mile of the confluence with the Animas River. Both sampling locations were combined into one EU.

- *Mainstem Mineral Creek*: the section evaluated in this BERA is represented by sampling location M34 found on the creek just upstream of the confluence with the Animas River.

The main goal of this BERA is to refine the risk estimates presented in the Screening-Level Ecological Risk Assessment (SLERA; TechLaw, 2013) for different types of receptor groups, as follows:

- benthic invertebrates exposed to sediment in mainstem Cement Creek, mainstem Mineral Creek, the Animas River above Cement Creek, and the Animas River below Mineral Creek (note: no sediment samples were collected from the Animas River between mainstem Cement Creek and mainstem Mineral Creek),

- benthic invertebrates exposed to pore water collected from undisturbed bedded sediment in the Animas River,

- fish exposed to surface water in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River, and

- four wildlife species representing different trophic levels exposed via ingestion of surface water, sediment, and food items from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

The analytes of interest to this BERA consist of Aluminum (Al), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni), Selenium (Se), Silver (Ag), and Zinc (Zn). These metals represented the Contaminants of Potential Ecological Concern (COPECs) investigated in the SLERA.

This BERA is a realistic evaluation to quantify risk to community and wildlife-level receptors exposed under current conditions. The evaluation recognizes that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not support viable fish or macroinvertebrate communities before large-scale mining activities started in the 19th century due to naturally high levels of metals and low pH levels in their surface waters. These two waterways were nonetheless included in this BERA to provide risk estimates and help identify risk drivers and exposure pathways of concern. It was expected that evaluating these waterways within a risk-based context would provide information to support a scientific management decision point for discussion among the stakeholders.

The surface water data represented dozens of samples collected from the five EUs between May 2009 and September 2014. The sediment data set was substantially smaller and consisted of analytical data collected from those same waterways during five sampling events in May 2012, October 2012, May 2013, April 2014, and September 2014. The pore water data set consisted of

analytical data collected in April and September 2014. Samples obtained by the United States Environmental Protection Agency (EPA) and others before May 2009 as part of earlier investigations were not evaluated in this BERA in order to focus on “current” exposure conditions. The available information was reviewed to identify assessment endpoints and measures of effect, and to develop a Conceptual Site Model (CSM) which showed the movement of contaminants from the sources to the receptors.

The effects evaluation used chronic surface water benchmarks (CSWBs) (hardness adjusted, if necessary), plus no-effect and effect sediment benchmarks, to quantify toxicity to aquatic community-level receptor groups exposed to surface water, sediment, and pore water. No-effect and effect Toxicity Reference Values (TRVs) for birds and mammals were used to assess the toxicity of metals via ingestion by wildlife receptors. In addition, surface water and sediment toxicity tests were performed in the laboratory on samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above Cement Creek and below Mineral Creek to measure effects to benthic invertebrates (the amphipod *Hyalella azteca*) and juvenile rainbow trout (*Oncorynchus mykiss*).

EPA and others assessed the benthic community structure and function in the five EUs and obtained benthic invertebrate samples for tissue residue analysis as part of additional sampling efforts performed in 2014 to enhance the existing database in support of this BERA.

The original surface water and sediment COPECs for benthic invertebrates and fish were re-selected in this BERA because more analytical data were generated since the SLERA was released in 2013. A metal detected at least once in sediment was retained for use in wildlife food chain modeling but only if it was also identified as an “Important Bioaccumulative Compound” in Table 4-2 of *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment* (EPA,2000).

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River were treated as separate EUs to derive Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Exposure Point Concentrations (EPCs) for use in the baseline evaluation. The ProUCL software (EPA, 2013) was used whenever possible (depending on the size of the datasets) to calculate 95% Upper Confidence Levels (UCLs) for use as the RMEs and arithmetic means for use as CTEs. To fine tune the exposure to aquatic, community-level receptors, the surface water data were further split into three hydraulic periods, namely the pre-runoff period (February to April), runoff period (May and June), and the post-runoff period (July to November). No surface water data were available for December or January.

The sediment data set was too sparse (five samples) to be split up into the three hydraulic periods. Instead, the sediment analytical data were combined across seasons for each EU to calculate RME and CTE EPCs for the sediment COPECs.

The EPC calculation method varied depending on the EUs, as follows:

- *Animas River above mainstem Cement Creek*: the surface water, sediment, and pore water analytical data were combined across the six sampling locations into separate datasets to calculate COPEC-specific RME and CTE EPCs for these three matrices. Also, a benthic invertebrate sample was collected from two sample locations in this reach for use in tissue residue analysis. These two samples were combined to calculate a mean and maximum tissue concentration for each COPEC for use in wildlife food chain modeling.

- *Animas River between Cement and Mineral Creeks*: only two surface water data points were available from the two sampling locations in this reach of the river. No sediment or benthic invertebrate samples were collected. Hence, wildlife receptors could not be evaluated either because those would have required either (a) sediment analytical data to estimate the tissue residue levels in the food items for use in the food chain models, or (b) measured benthic invertebrate tissue residue data. The surface water analytical data were summarized by sampling location for calculating COPEC-specific RME and CTE EPCs to evaluate the fish community.

- *Animas River below mainstem Mineral Creek*: up to several miles separate the various EUs in this lower reach of the river. As a result, the BERA assumed that wildlife receptors would not be exposed across this entire reach. Instead, the surface water, sediment, pore water, and benthic invertebrate analytical data were summarized by sampling location to calculate COPEC-specific RME and CTE EPCs for use in food chain modeling and to assess exposure to the benthic invertebrate and the fish community (note: only one benthic invertebrate tissue sample was collected at each sampling location in the Animas River below mainstem Mineral Creek. Hence, the invertebrate tissue RME and CTE EPCs used in the food chain models were the same at each EU).

- *Mainstem Cement Creek*: this BERA did not evaluate wildlife receptors foraging in this EU because the SLERA showed that current chemical conditions in this waterway are too degraded to provide forage for wildlife. The surface water and sediment data from the two sampling locations at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community. No pore water samples were collected from this EU.

- *Mainstem Mineral Creek*: this BERA did not evaluate wildlife receptors foraging in this EU because current chemical conditions in this waterway are too degraded to provide enough forage for wildlife. The surface water, sediment, and pore water data from the sampling location at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

Exposure to the four wildlife receptor species foraging in the reaches of the Animas River above mainstem Cement Creek and below mainstem Mineral Creek, was quantified using a food chain model which calculated RME and CTE Estimated Daily Doses (EDDs) based on ingesting surface water, sediment, and food items. The food items consisted of benthic invertebrates

(measured COPEC levels), fish (estimated COPEC levels based on sediment data), and aquatic plants (estimated COPEC levels based on sediment data), depending on the target wildlife species. Contaminant levels in fish and aquatic plants were estimated by multiplying the sediment RME and CTE COPEC levels by published COPEC-specific sediment-to-fish accumulation factors or by using published regression equations. Contaminant levels in benthic invertebrates were based on measured tissue samples collected from the Animas River.

Risk was quantified using the Hazard Quotient (HQ) method, which compares measured exposures (i.e., RME and CTE surface water, sediment and pore water EPCs) or estimated exposures (RME and CTE wildlife EDDs) to CSWBs, no-effect and effect sediment benchmarks, and wildlife TRVs.

A COPEC-specific HQ was then calculated using the following general equation:

$$HQ = EPC \text{ or } EDD/\text{benchmark or } TRV$$

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	RME and CTE EPC (μg/L or mg/Kg)
EDD	=	RME and CTE EDD (mg/kg bw-day)
Benchmark	=	CSWBs or sediment no effect and effect benchmarks (μg/L or mg/kg, respectively)
TRV	=	no effect and effect wildlife TRV (mg/kg bw-day)

HQs equal to or above 1.0 identified a potential for ecological risk, whereas HQs below 1.0 were used to eliminate chemicals with assurance that they did not pose a risk.

Besides assessing the potential impacts associated with RME and CTE exposures, the risk characterization for fish and benthic invertebrates also viewed each surface water and sediment sample as an individual exposure event in time. Hence, HQs were calculated for all available surface water and sediment samples and were used to prepare "scatter plots" by sampling station and hydraulic period (i.e., pre-runoff, runoff, and post-runoff for surface water samples only). Those plots were then used to identify patterns of risk across the waterways and hydraulic periods. Minisipper surface water analytical data collected on a daily basis between mid-April 2014 and mid-July 2014 at four locations on the Animas River were used semi-quantitatively in the risk characterization to support the risk conclusions pertaining to fish.

Finally, toxicity data from fish and benthic invertebrates exposed to surface water and sediment in the laboratory were evaluated statistically to determine which of the observed responses were significantly different from the laboratory control sample (note: an upstream reference sample was not available for the statistical comparison due to a lack of reference locations that had not been impacted).

Uncertainty is inherent in this BERA because many assumptions were made in order to proceed with the investigation. These assumptions affected all aspects of the assessment including the

CSM, the effects analysis, the exposure analysis, and the risk characterization. The uncertainty analysis identifies and discusses the major assumptions made in this BERA. It also provides a short description to determine if the assumptions were likely to have overestimated or underestimated the potential for ecological risk. The end result is a balanced overview of the degree of uncertainty in this report's results to help risk managers understand the full extent of potential ecological risk to aquatic community and wildlife receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton.

ES.2 Risk conclusions for benthic invertebrates

Taken together, the four independent measurement endpoints evaluated in this BERA (i.e., sediment HQs, pore water HQs, sediment toxicity, and community structure and function) indicate that the benthic invertebrate communities in the Animas River between A60 and BB, and in mainstem Cement and Mineral Creeks, were all impacted. The two creeks were the most impaired of the four endpoints. In addition, comparing four benthic community metrics collected from the Animas River in September 2014 against historical data on those same four metrics indicated that the benthic invertebrate community in the Animas River has not consistently improved over the last decade, with the possible exception at sampling location A75D.

ES.3 Risk conclusions for fish

- **Mainstem Cement Creek:**

The chemical conditions in surface water from mainstem Cement Creek are highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests showed that surface water collected from this EU in November 2012 (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence suggests that the fish community in mainstem Cement Creek (if present) would experience lethal stress under current conditions.

- **Mainstem Mineral Creek:**

The chemical conditions in surface water from mainstem Mineral Creek appear less severe than in mainstem Cement Creek for the local fish community. However, serious pH drops during the pre-runoff period coupled with high Al levels during the pre-runoff and post-runoff periods suggests that fish may experience high stress in the winter as well as summer and fall, but that survivors could possibly recover during the rest of the year (spring). The toxicity tests showed surface water collected from this EU in November 2012 (i.e., post-runoff period) and April 2013 (pre-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence suggests that the fish community in mainstem Mineral Creek (if present) would likely experience high stress under current conditions.

- **Animas River above mainstem Cement Creek:**

The chemical conditions in surface water from this reach of the Animas River between A60 and A68 indicates the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggested that chronic toxicity to the fish community was possible, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, was not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout acutely exposed to surface water from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggests that the fish community in this reach of the Animas River could be stressed during much of the year. This conclusion is supported by the fact that daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at location A56 (upstream of A60) showed the presence of potentially severe chronic toxicity associated with dissolved Al, Cd, Cu, Pb, and Zn during the pre-runoff and runoff periods.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

Little chemical information on the quality of the surface water is available because only two samples were collected and no acute toxicity testing was performed. The limited amount of data suggests that this reach of the Animas River is likely to be lethal to fish, mostly due to low pH and high levels of aluminum, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflects the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre and post-runoff periods were acutely toxic to juvenile rainbow trout. Surface water samples collected during the same two hydraulic periods from the EUs further downstream did not show acute toxicity, suggesting that the effect has been "diluted out". However, the preponderance of evidence shows that Al, Cd, and Zn in surface water may exert chronic effects on the fish community to at least the BB EU located about 30 miles downstream from Silverton. This conclusion is supported by two additional lines of evidence:

  - Daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at locations A73, A75D and BB showed the presence of low-grade and multi-week chronic toxicity associated with dissolved Al, Cd, and Zn during the pre-runoff and runoff periods.

  - A fisheries survey performed by the Colorado Division of Wildlife (CDOW) in 2010 on the Animas River in the vicinity of sampling locations A72, A73, and A75D/A75B showed a severe decline of the trout populations at all three locations between 2005 and 2010. CDOW ascribed this collapse to a drastic reduction in surface water quality apparently associated with the discontinuance of a water treatment project in the Gladstone area on Cement Creek upgradient from Silverton. A 2014 follow-up fisheries

survey by CDOW in the vicinity of sampling location A75D/A75B showed that the trout population had essentially been extirpated.

ES.4 Risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

Potential for minimal risk to wildlife receptors was identified for Zn (for the American dipper) and Pb (for the belted kingfisher). The American dipper was also used as a surrogate species to perform a conservative assessment of risk for the southwestern willow flycatcher—a federally and state-listed bird species. The evidence does not suggest that this species is at substantial risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68.

- **Animas River below mainstem Mineral Creek**

The potential for risk to wildlife receptors in this reach of the Animas River was restricted to Cu in the American dipper at sampling locations A73B and A75B, with minor risk from Cu to the mallard (100% diet only) at the same two locations. The remaining COPECs were of no concern to any of the wildlife receptors due to the hazard quotient being less than one for those specific metals thus eliminating them from the pool. Benthic invertebrates were not collected for tissue residue analysis from sampling locations A73B and A75B. Hence, the levels of metals in benthic tissues at these two locations were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors for use in the food chain model. It is noteworthy that the only two sampling locations with excessive risk from Cu are A73B and A75B. Given this pattern, the conclusion is that the risk from Cu was hypothetical and unlikely to be realized in the field.

The increased risk of Cu in the American dipper versus the mallard was driven almost entirely by the higher food ingestion rate of the former compared to the latter (0.0519 kg/kg/BW-day, Dry Weight (dw), versus 0.2173 kg/kg BW-day, dw which results in a ratio of 4.2). This difference was driven by the fact that the average adult American dipper weighs 0.0565 kg and the average adult mallard weighs 1.162 kg. As such, the American dipper was a suitably sensitive wildlife receptor for future risk evaluations on this river system.

1.0 GENERAL INTRODUCTION

1.1 Scope

This report is a BERA for the aquatic habitats in the Animas River Mining District, located in San Juan County, CO. This report is a follow-up to a SLERA finalized in 2013 (TechLaw, 2013).

The SLERA identified numerous COPECs for community-level and wildlife receptors associated with mainstem Cement Creek, mainstem Mineral Creek and the Animas River in the vicinity of Silverton. Those COPECs were further analyzed to determine if they represented a risk to various receptor groups in the three waterways. As such, the SLERA provided an initial and conservative assessment of risk, and allowed for the determination to be made if enough information was available to support decision making. The SLERA identified unacceptable risk to both community-level and wildlife receptors, which prompted the need for additional sampling to provide more data for use in this BERA.

These data were collected in 2012 and 2013 for inclusion in an initial draft BERA report submitted to EPA in February 2014. This expanded evaluation did not attempt to separate natural background contamination from past mining-related contamination, but instead assessed the risk from all sources combined. The draft BERA was reviewed by EPA and helped identify remaining data gaps that were addressed during additional sampling in April, May and September 2014 (TechLaw, 2014). This BERA is the result of these efforts.

The Animas River was divided into three reaches to support this BERA, as follows:

- *The Animas River above mainstem Cement Creek*: this reach of the Animas River covers about two river-miles between sampling locations A60 and A68. Location A56, which is situated about 1,000 ft upgradient of A60, represents regional "upstream" conditions. A56 is located just above the Mayflower Mill and Arrastra Creek. Location A68 is about 1,000 ft upstream of the confluence with Cement Creek and is therefore not influenced by the creek (see **Figure 1.1**). Note that the naming of this stretch of the Animas River is arbitrary, and that no samples collected upgradient from sampling location A56 were included in this BERA. Also, the text of this BERA does not refer to sampling location A56 as "reference" or "background" because sources of contamination are known to exist in the watershed upstream from A56.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*: this reach of the Animas River covers about one river-mile between the confluences of the two creeks. Location A69A is about 3,000 ft downstream of the confluence with mainstem Cement Creek (just upstream of Idaho Gulch), whereas location A70B is just upstream of the confluence with mainstem Mineral Creek (see **Figure 1.1**).

- *The Animas River below mainstem Mineral Creek*: this reach of the Animas River covers about 30 river-miles between sampling locations A71B and BB (see **Figures 1.1 and 1.2**). The following values represent the approximate distance (in river-miles, where

appropriate) separating the point where mainstem Mineral Creek enters the Animas River in Silverton and the downstream sampling locations: A71B—around 300 ft, A72—around 3,500 ft, A73/A73B—5.9 miles, A75D/A75B—18.9 miles, and BB—30 miles. Note that the naming of this stretch of the river is also arbitrary, and that no samples collected downgradient from BB are assessed in this BERA.

Two additional waterways that are also included in this BERA, are as follows:

- *Mainstem Cement Creek*: the section evaluated in this BERA is represented by sampling locations CC48 and CC49, found on the creek just upstream of the confluence with the Animas River (see **Figure 1.1**). The SLERA (TechLaw, 2013) also evaluated two more locations upstream from CC48, but these were not included in this BERA because the SLERA showed that neither one could support aquatic life under current conditions.

- *Mainstem Mineral Creek*: the section evaluated in this BERA is represented by sampling location M34, found on the creek just upstream of the confluence with the Animas River (see **Figure 1.1**).

Each of these five stream and river reaches were evaluated as separate EUs to select COPECs, calculate exposures, and quantify the potential for ecological risk.

1.2 General ecological risk assessment approach

The following guidance and reference documents were used to prepare this BERA:

- EPA, 1997. *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final*. Environmental Response Team, Edison, NJ.

- EPA, 1998. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F. EPA (1997) provides the general framework for planning and conducting the investigation.

1.3 Goals and objectives

Benthic invertebrates and fish represent the valued ecological resources to be protected in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton (the "Site"). In addition, four representative species of birds and mammals were also retained as ecological resources to be protected in the Animas River. These community-level and wildlife receptors provide the basis to develop Site goals and objectives, and to select assessment endpoints for this BERA.

The ecological risk management goal for the Site is defined as follows:

> "*Promote healthy communities of aquatic and wildlife receptors in the waterways affected by Site-related contamination.*"

Four ecological risk assessment objectives were identified to accomplish this goal:

- Identify the presence of Site-related COPECs that may pose a threat to one or more of the receptor groups;
- Document the potential exposure to those receptor groups using the available analytical datasets;
- Develop risk estimates and discuss major uncertainties; and
- Provide data for risk managers to determine the potential for ecological risk and to have enough information to support the risk management decision-making process.

This report recognizes that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported a viable fish or invertebrate community before large-scale mining activities started in the 19th century due to naturally-high levels of metals and low pH levels in those surface waters (Church *et al*., 2007). These two waterways are nonetheless included in this report in order to provide a conservative risk evaluation and help identify risk drivers and exposure pathways of concern. It is expected that evaluating these naturally impaired waterways within a risk-based context will provide more information to support a scientific management decision point for discussion among the various stakeholders.

2.0 BASELINE PROBLEM FORMULATION

2.1 Data processing

2.1.1 Compiling a database for use in this BERA

The final product of the data evaluation and summarization process is a comprehensive database for all the surface water, sediment, pore water and benthic tissue analytical data collected between May 2009 and September 2014 for the Site.

Individual data sets were developed by compiling analytical results for each matrix of interest (i.e., surface water, sediment, pore water, benthic tissues), analyte group (i.e., total metals, dissolved metals, and pH), EU (i.e., mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches), and sampling locations within each EU, if applicable.

- **Appendix 1** provides the analytical data for pH, hardness, and total and dissolved metals concentrations measured in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River between May 2009 and September 2014.
- **Appendix 2** provides the analytical data for total metals in bulk sediment samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River in between 2012 and September 2014. The USGS has historically collected and evaluated sediment data from the Upper Animas River basin (e.g., see Chapter E19 in Church *et al*., 2007). Those data, which were obtained over a decade ago, were excluded from the evaluation because they were not considered to represent current exposure conditions.
- **Appendix 3** provides the analytical data for hardness and dissolved metals measured in the pore water samples collected from the Animas River.
- **Appendix 4** provides the tissue residue data (both wet weight and dry weight) for the benthic invertebrates collected from the Animas River in September 2014.

Tables 2.1, 2.2 and 2.3 summarize the surface water, sediment, and pore water sampling efforts, respectively, that have occurred in the various EUs between May 2009 and September 2014 (Note: Section 4.3 explains how surface water samples collected in different months between May 2009 and September 2014 were combined into three hydraulic periods for use in the exposure calculations). The surface water sampling efforts in support of this BERA focused heavily on sampling locations A68 (Animas River above mainstem Cement Creek), A72 (Animas River below mainstem Mineral Creek), CC48 (mainstem Cement Creek close to the confluence with the Animas River) and M34 (mainstem Mineral Creek close to the confluence with the Animas River). The other sampling locations were either not sampled or sampled only occasionally.

2.1.2 Data summarization method

The analytical data for total metals (unfiltered samples), dissolved metals (filtered samples), and pH in mainstem Cement Creek, mainstem Mineral Creek, the three Animas River reaches are summarized separately by waterway, as follows:

- frequency of detection (number of detected values over the number of samples analyzed),
- minimum detected value (with data qualifier),
- maximum detected value (with data qualifier), and
- sampling location of the maximum detected value.

The following procedures were applied to compile data for a metal in a given matrix to calculate the summary statistics used in this BERA:

- Results assigned qualifiers indicating that an analyte was positively detected or presumptively present (i.e., data without flags or flagged as "D" [diluted] or "J" [estimated]) were retained as reported for use in the exposure calculations.

- Results assigned qualifiers indicating that an analyte was not positively detected (i.e., data flagged as "U" [non-detected] or "UJ" [estimated non-detected]) were retained at one half their Detection Limit (DL).

- Any results considered of inadequate quality (i.e., data qualified as "R") were not used in the risk calculations.

- Analytical results for samples collected from the same location but during different sampling events were considered unique samples and were not combined.

- Analytical data from duplicate samples (i.e., samples collected at the same location and date) were averaged. These data were handled as follows:
    - If both samples had a detected value, the average concentration and the most conservative of the two data qualifiers was used as the maximum value (e.g., if one value had no flag and the second value was flagged as "J", then the average concentration was calculated and flagged as "J").

    - If one of the duplicates had a detected value and the other had an undetected value, then only the detected value and its associated flag (if available) was used as the maximum value. This approach was necessary because in some cases the undetected value was substantially higher than the detected value due to a difference in the way the samples were diluted, thus affecting the DLs. Taking an average of these two numbers would have artificially inflated the maximum value.

    - If the values in both samples were non-detect, then the highest of the two method DLs was used.

2.2 Problem formulation

2.2.1 Environmental setting and contaminants at the Site

2.2.1.1 Brief Site description and history

The information summarized in this subsection was obtained from Church, S.E., P. von Guerard, and S.E. Finger, eds., 2007. *Integrated investigations of environmental effects of historical mining in the Animas River watershed, San Juan County, Colorado. U.S. Geological Survey Professional Paper 1651*, 1,096p. plus CD-ROM (in two volumes), and EPA, 2012. *Final Sampling and Analysis Plan/Quality Assurance Project Plan. 2012 Sampling Events. Upper Animas Mining District, Gladstone, San Juan County, Colorado (May 2012).*

The mining district is located in the northernmost headwaters of the Animas River watershed in San Juan County, CO. It covers the drainage basin of the Animas River at and upstream of the town of Silverton, CO, its two main tributaries (i.e., Cement Creek and Mineral Creek), and the Animas River below the confluence with Mineral Creek. Elevations in the watershed range between about 9,000 ft and 13,500 ft.

The discovery of gold and silver brought miners to the area in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined. Not until 1890 was a serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. Twelve concentration mills operated in the valley by 1900. All sent their products to the Kendrick and Gelder Smelter near the mouth of Cement Creek in Silverton.

Mining and milling operations slowed down around 1905, and mines were consolidated into fewer and larger operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued in the basin whenever prices were favorable. Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town developed in the 1880s in response to the onset of mining. The town was the central location and railroad terminus for milling and shipping mine ores from the surrounding valley. Gladstone declined in the 1920's and no remnants of it remain visible today.

The Sunnyside Mine was the only active year-round mine left in the county by the 1970's. This mine ceased production in 1991, and underwent extensive reclamation. The Gold King Mine's permit with the Division of Reclamation, Mining and Safety was revoked by the Colorado Mined Land Reclamation Board and the financial warranty bond was forfeited in 2005.

The Sunnyside Mine was accessed through the American Tunnel which has its portal in Gladstone. The American Tunnel drained up to 1,600 gallons per minute (gpm) of water prior to bulkhead installations. The Standard Metals Corporation constructed a lime feed and settling pond-type treatment facility in Gladstone in 1979. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). SGC installed eleven

bulkheads within the Sunnyside Mine as part of a court-ordered consent decree to terminate their discharge permit. These bulkheads greatly reduced the volume of discharge from the American Tunnel. Currently, between 70 and 100 gpm continue to discharge from the American Tunnel, presumably from near-surface groundwater. SGC met all the terms of the consent degree in 2002.

The treatment facility, operations, and permit were transferred to the Gold King Mines Corporation in January 2003. The settling ponds were deeded to the San Juan Corporation by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation required SGC to reclaim the four settling ponds (completed in 2005) when the San Juan Corporation and the SGC lease were terminated. The Gold King Mines Corporation was subsequently evicted and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien-holder. The American Tunnel portal reclamation and the removal of some out-buildings were completed in 2006. The Bureau of Land Management (BLM) manages land associated with the American Tunnel portal and its immediate vicinity, whereas the San Juan Corporation owns most of the surrounding land.

Many abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, Red and Bonita, Eveline, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainages that produce flows of between 30 and 300 gpm that directly or indirectly enter Cement Creek and eventually reach the Animas River. The Animas River Stakeholder Group, the BLM, and the Division of Reclamation, Mining and Safety have completed remediation projects at the Eveline, Henrietta, Joe and John, and Lark mines.

Existing and historical data suggest that conditions have changed recently at several locations where site-impacted waters enter upper Cement Creek. For example, flows have increased at the Red and Bonita mine and the upper Gold King 7 Level. The data also show higher levels of Al, Cd, Cu, Mn and Zn in Cement Creek, and downstream in the Animas River at and below Silverton between 2005 and 2007. These increases coincide with the end of active water treatment in Gladstone in 2005 and the installation of bulkheads at the American Tunnel.

The headwaters and tributaries of Cement Creek, Mineral Creek, and the Animas River originate in treeless alpine regions. With a few exceptions, the streams follow high-gradient, narrow glaciated valleys. The vegetation along those valleys is rather sparse in the presence of extensive areas of exposed rock and talus (i.e., a sloping mass of rock debris at the base of a cliff).

Past surveys of fish and benthic invertebrate communities showed that the headwaters of the Animas River above Silverton, the main stems of Cement and Mineral Creeks, and several smaller tributaries support little or no aquatic life due to the presence of site-related contamination. On the other hand, South Fork Mineral Creek and several tributaries of the upper Animas River drain basins that provide substantial acid-neutralizing capacity and support viable trout populations. The Animas River between Maggie Gulch (located about eight river-miles

upstream from Silverton) and the mouth of Cement Creek in Silverton, supports brook trout and a robust invertebrate community (see Chapters D and E18 in Church *et al.*, 2007), which suggests substantial improvements in surface water quality since the 1970's. Note, however, that sections of the Animas River further upstream from Maggie Gulch are still severely impacted by past mining activities. The stream biota in the Animas River downstream from Silverton are also degraded due to input from Cement and Mineral Creeks (see Chapters A, D, E18, and E19 in Church *et al.*, 2007).

2.2.1.2 Past sampling of environmental media

EPA and others have collected numerous samples over the last 20 plus years from the Site for chemical analyses and evaluation. However, this BERA only used analytical data from surface water and sediment collected between 2009 and 2014 from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek. This BERA also evaluated two rounds of pore water samples collected from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek in April and September 2014. This approach ensured that the aquatic exposures reflected "current" conditions.

2.2.1.3 Suspected contaminants

Acid conditions result from the interaction of sulfide minerals, water, and oxygen, which together yield highly-acidified drainage water. This water dissolves metals present in bedrock, veins, ore, tailings, and waste rock, such as: Al, Cd, Cu, and Zn. These dissolved metals are then transported over land or via groundwater to small tributaries that connect to the Site.

The higher pH of the surface water in the Animas River above the confluence with mainstem Cement Creek could cause some of the dissolved metals brought in by the two creeks to precipitate out of solution and become integrated into the substrate. Metals may also be carried in particulate form (e.g., fine tailings) by the water current and deposited in lower-energy areas of the affected waterways. Previous investigations showed that numerous metals in surface water samples from the three targeted waterways exceeded applicable water quality standards (see Chapter D in Church *et al.*, 2007).

2.2.2 Ecological resources potentially at risk

The ecological resources of concern in this BERA consisted of (a) fish exposed to metals in surface water, (b) benthic invertebrates exposed to metals in sediment and pore water, and (c) four species of wildlife receptors exposed to metals in surface water, sediment, and prey items obtained from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

A list of Threatened and Endangered (T&E) species was obtained from the Colorado Wildlife Heritage Foundation and from the Colorado Parks and Wildlife species of concern list for San Juan County, CO (updated December 2011). Two mammals identified on the lists were the lynx (*Lynx Canadensis)* and the wolverine (*Gulo gulo)*. The lynx is listed as federally threatened and

state endangered while the wolverine is listed as state endangered. The boreal toad (*Bufo boreas boreas)* is listed as state endangered. For birds, the southwestern willow flycatcher (*Empidonax trailii extimus)* is listed as federally endangered and state endangered. This T&E species, if present in the riparian habitat along the Animas River at and below Silverton, was assumed to have the potential for exposure to Site-derived contamination.

The southwestern willow flycatcher is a small passerine bird which breeds in dense riparian habitats along rivers, streams, or wetlands and feeds on insects. The riparian vegetation can be dominated by dense growths of willows (*Salix* sp.), seepwillow (*Baccharis* sp.), or other shrubs and medium-sized trees. An overstory of cottonwood (*Populus* sp.), tamarisk (*Tamarix* sp.), or other large trees may be present but this is not necessary. In some areas, the flycatcher nests in habitats dominated by tamarisk and Russian olive (*Eleagnus angustifolia*). A key characteristic of breeding habitat appears to be the presence of dense vegetation, usually throughout all vegetation layers present within the habitat.

Almost all southwestern willow flycatcher breeding habitats are less than 20 yards from water. At some sites, surface water is present early in the nesting season, but gradually dries up as the season progresses. Ultimately, the breeding site must have a water table high enough to support riparian vegetation.

Suitable riparian habitat for the southwestern willow flycatcher is available along the shoreline of the Animas River downstream of Silverton, and especially at the lower elevations below BB and James Ranch. This BERA conservatively assumes that the species might be present based on its listing in San Juan County and the existence of riparian habitat. The American dipper (see further below) served as a surrogate for this species.

2.3 Preliminary fate and effects evaluation

A preliminary evaluation of the fate and transport of Site-related contamination helped to identify potentially complete exposure pathways. A brief summary of the fate and effects information, together with data on the ecotoxicity of Site-related contamination to the community-level and wildlife receptors are discussed below.

2.3.1 Fate and transport

The information provided by Church *et al*. (2007), was reviewed to determine which fate and transport mechanisms might result in complete exposure pathways to aquatic, community-level receptors in the three targeted waterways or to wildlife receptors feeding on aquatic food items in the Animas River (Note: The BERA assumed that wildlife receptors foraged only in the Animas River because fish and aquatic invertebrates appear to be largely absent from mainstem Cement and Mineral Creeks under current conditions).

The goal was to identify the major elements of a complete exposure pathway, which consist of the following components:

- source(s) of contamination,
- release and transport mechanisms,
- contact points and exposure media,
- routes of entry, and
- key receptors.

Each of these components is discussed below.

- **Sources of contamination**

The major sources of contamination relating to past mining in the watersheds of Cement Creek, Mineral Creek, and the Animas River above Silverton consist of one or more of the following activities: tunneling to reach the ore veins and to drain groundwater out of mine workings, disposal of waste and overburden rock, and disposal of mine tailings on land and in waterways.

Additionally, natural sources of regional contamination consist of groundwater that has come in to contact with undisturbed mineralized materials.

- **Release and transport mechanisms**

Some of the rocks are enriched with sulfide minerals (e.g., pyrrhotite, pyrite and chalcopyrite). These minerals react with water and atmospheric oxygen over time. The oxidation process generates sulfuric acid, which in turn causes metals to dissolve out of host rock, vein rock, waste rock, and tailings. This highly-acidic and metal-rich effluent is toxic to aquatic receptors due to its low pH and high dissolved metals content.

The following release and transport mechanisms may potentially affect the concentration and spatial distribution of metals in the affected waterways:

- dissolution and leaching of metals from mine waste, host rock, or vein rock into groundwater,
- migration of metals in groundwater to sediment and surface water in adjacent surface water bodies, and its attenuation by dilution or dispersion and sorption,
- transport of metals adsorbed to soil and tailings particles via terrestrial runoff,
- transport of metals in surface water runoff, and
- trophic transfer of metals incorporated in aquatic food chains.

The potential release of Site-related contamination and its transport from the sources to points of contact with aquatic receptors in the three targeted waterways depends on its chemical speciation, concentration, presence of nearby surface water bodies, and the extent and duration of precipitation or snowmelt events. Surface water runoff and groundwater infiltration are particularly important transport mechanisms for soluble species of metals.

- **Contact point and exposure media**

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of Animas River above, across, and below Silverton were the contact points evaluated in this BERA. The exposure media were as follows:

- surface water,
- sediment,
- pore water, and
- prey items for wildlife receptors (only in the Animas River above and below Silverton).

- **Routes of entry**

The main routes of entry evaluated in this BERA for aquatic community-level receptors, and wildlife receptors feeding on aquatic prey, are as follows:

- direct contact with surface water, sediment or pore water via dermal or gill absorption (aquatic community-level receptors),
- surface water ingestion (wildlife receptors),
- incidental sediment ingestion (wildlife receptors), and
- ingestion of contaminated food items (wildlife receptors).

Exposure to metals via inhalation or skin absorption was omitted because it was considered to be minor for wildlife receptors feeding on aquatic food items.

- **Key receptors**

  - **Aquatic receptors**

  This BERA assumes that benthic invertebrates live on and within the substrate in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River. It also assumed that fish live in the water column of mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River.

  - **Wildlife receptors feeding on aquatic food items**

  This BERA assumes that the following types of wildlife receptors could become exposed to Site-related contamination while feeding in the three reaches of the Animas River: (a) invertivorous birds, (b) omnivorous birds, (c) piscivorous birds, and (d) herbivorous mammals. Wildlife receptors were not evaluated for risk in mainstem Cement Creek and mainstem Mineral Creek because these two waterways are too impacted under current conditions to provide forage to consistently sustain wildlife populations. Wildlife receptors were also not evaluated for risk on the Animas River across from Silverton

because this reach was not sampled for sediment, which was needed to estimate the contaminant levels in the food items ingested by the wildlife receptors.

- **Ecotoxicity**

Acidity and metals are the two major chemical stressors in the aquatic habitats of interest to this BERA.

Acidity/low pH

Sulfuric acid is released when water and oxygen interact with sulfide-rich materials. Low pH is toxic to aquatic receptors. Sensitive species of fish and aquatic invertebrates experience increased mortality at a pH of around 6.0. For example, brook trout populations are known to disappear from streams when pH drops to the low 5s for an extended period of time. Other trout species (e.g., rainbow trout or brown trout) are considered more sensitive to increased acidity and are therefore affected sooner than brook trout.

Metals

High acidity solubilizes metals, resulting in metals-enriched surface water runoff. Dissolved metals are of the highest concern because, unlike metals associated with the particulate fraction, they are bioavailable to exert direct toxicity to aquatic receptors.

The relative sensitivity of four trout species (namely, brook trout, brown trout, rainbow trout and cutthroat trout) to Cd, Cu, and Zn was determined in support of this BERA (see **Appendix 5**). The four trout species included in this evaluation may be found in the Animas River above and below Silverton. The three metals of concern are known to be associated with past and current mining and non-mining-related releases in the Animas River watershed.

A literature search was performed to obtain 96-hour acute toxicity data on juvenile life stages to derive Species Mean Acute Values (SMAVs) for the three target metals. These SMAVs were standardized to a hardness of 50 mg/L $CaCO_3$ to allow for a direct comparison of species sensitivity to the three metals.

The table below summarizes the results of this effort. **Appendix 5** provides additional details on the literature search criteria and statistical analysis of the data.

Relative sensitivity of four trout species to three metals in surface water			
Trout Species	**Target metal**	**SMAV**	**Relative sensitivity**
brown trout	cadmium	1.07 µg/L	1
rainbow trout	cadmium	1.29 µg/L	2
rainbow trout	copper	13.3 µg/L	1
brown trout	copper	17.8 µg/L	2
brook trout	copper	22.7 µg/L	3
cutthroat trout	copper	29.5 µg/L	4
rainbow trout	zinc	121 µg/L	1
cutthroat trout	zinc	141 µg/L	2
brown trout	zinc	288 µg/L	3
brook trout	zinc	734 µg/L	4

The information provided in the table above can be summarized as follows:

Cadmium

- Only acute toxicity data for brown trout and rainbow trout were available to calculate Cd SMAVs. It is not known how much more or less sensitive brook trout and cutthroat trout may be compared to these two species.
- The difference in SMAVs between brown trout and rainbow trout was minimal and unlikely to be significant.
- Cd was the most toxic of the three target metals to trout.

Copper

- Acute toxicity data were available to calculate Cu SMAVs for all four trout species.
- The rainbow trout was over two times more sensitive to Cu than the cutthroat trout. The sensitivities of brown trout and brook trout fell between these extremes.
- The toxicity of Cu fell in between that of Cd and Zn

Zinc

- Acute toxicity data were available to calculate Zn SMAVs for all four trout species.
- The rainbow trout was six times more sensitive to Zn than the brook trout. The sensitivities of cutthroat trout and brown trout fell between these extremes.
- Zn was the least toxic of the three target metals.

Based on this information, it can be concluded that the rainbow trout appears to be consistently very sensitive to the three metals. The relative sensitivities of the other three species to Cu and Zn are not so consistent and vary by species.

Both acidity and dissolved metals affect osmoregulation in aquatic organisms by changing the integrity of the cell junctions in the gill tissues. The cell junctions become "leaky" with increasing levels of H^+ (protons) or metals, thereby allowing blood electrolytes to diffuse out of the gill tissue, and water to diffuse into the bloodstream. Death results when blood electrolyte levels drop below a critical physiological threshold, which varies from species to species.

2.3.2 Ecosystems potentially at risk

The potentially impacted aquatic habitats evaluated in this BERA consisted of mainstem Cement Creek, mainstem Mineral Creek, and three reaches of the Animas River, as follows: Animas River above the confluence with mainstem Cement Creek (about 2 miles, between sampling locations A60 to A68), Animas River between mainstem Cement Creek and mainstem Mineral Creek (about 1 mile, represented by sampling locations A69A and A70B), and Animas River below mainstem Mineral Creek (about 30 miles, between sampling locations A71B and BB).

2.3.3 Complete exposure pathways

Routes of exposure are the means by which COPECs can be transferred from a contaminated medium to ecological receptors. This BERA evaluated the following receptors and exposure routes:

- *Benthic invertebrates*: direct contact with sediment and pore water collected from mainstem Cement Creek (sediment only), mainstem Mineral Creek (sediment only), and the Animas River above mainstem Cement Creek (sediment and pore water) and the Animas River below mainstem Mineral Creek (sediment and pore water). Exposure of benthic invertebrates to substrate from the Animas River between mainstem Cement Creek and mainstem Mineral Creek could not be evaluated because no sediment samples were collected from this reach.

- *Fish*: direct contact with surface water in all three waterways.

- *Invertivorous birds*: ingestion of surface water, sediment, and benthic invertebrates from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

- *Omnivorous birds*: ingestion of surface water, sediment, benthic invertebrates, and aquatic plants from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

- *Piscivorous birds*: ingestion of surface water, sediment, and fish from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek (note: the belted kingfisher, which is the modeled piscivorous bird, is assumed to ingest a small amount of sediment because, even though this species primarily eats fish captured from within the water column, it is also known to feed on crayfish, stonerollers, and sculpin found right on the substrate).

- *Herbivorous mammals*: ingestion of surface water, sediment, and aquatic plants from the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

2.4 Target receptors

2.4.1 Introduction

Endpoints were selected to help quantify the risks to representative receptors that may be exposed to metals and low pH associated with current mine releases.

Assessment endpoints represent explicit expressions of the key ecological resources to be protected from harm. They should reflect sensitive populations, communities, or trophic guilds. Four criteria used for selecting the proposed assessment endpoints for the BERA are listed below. The ecological resource should:

- have relevance to the local ecosystem,
- be susceptible to the stressors of concern,
- have biological, social, or economic value, and
- be relevant to the risk management goals for the Site.

By considering these selection criteria, risks identified to one or more of the assessment endpoints will help inform the risk management decision process at the Site.

Measures of effect represent measurable ecological characteristics, quantified through laboratory or field experimentation, which can be related back to the valued ecological resources chosen as the assessment endpoints. Measures of effect were required because it is often not possible to directly quantify risk to an assessment endpoint. The measures of effect represented the same exposure pathway(s) and mechanisms of toxicity as the assessment endpoints in order to be relevant and useful.

Risk questions establish a link between assessment endpoints and their predicted responses when exposed to COPECs. The risk questions should provide a basis to develop the study design and evaluate the results of the Site investigation in the analysis phase and during risk characterization (EPA, 1997).

2.4.2 Representative species or communities

It is neither practical nor possible to evaluate the potential for ecological risk to all of the individual parts of the local aquatic ecosystem potentially affected by Site-related contamination. Instead, key components were identified to select those species or groups most likely to experience exposure to the stressors.

2.4.2.1 Community-level receptors

Benthic invertebrates

Benthic invertebrates form an integral link in all aquatic ecosystems. They play a key role in nutrient and energy transfers within those systems. They also process and assimilate organic material, feed on other invertebrates, and are themselves consumed by fish, birds, and mammals.

Metals with the potential to bioaccumulate can be transferred from the surface water, sediment or pore water into the benthic invertebrate community and up the food chain, thereby harming higher-level receptors. Significant alterations in invertebrate communities could also impact the energy cycling at the base of the aquatic food chain.

The substrate in the three waterways of interest in this BERA should be able to support a diverse benthic invertebrate community. Key invertebrates include amphipods and the aquatic life stages of numerous insect species (e.g., mayflies, stoneflies, caddisflies, dragonflies, etc.).

Note that it is considered possible that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported a macroinvertebrate community before large-scale mining activities started in the 19th century (Church *et al.*, 2007) due to naturally high levels of metals and low-pH levels. However, this BERA conservatively evaluates the potential ecological risk to a hypothetical benthic invertebrate community in these waterways in order to assess the current conditions. The outcome of this evaluation should be interpreted in a broader context, which considers naturally-altered surface water and substrate conditions.

Fish

The Animas River should be able to support a healthy fish community, consisting of cold-water stream species, such as trout and sculpin. The aquatic environment should provide such a community with a diverse food base, suitable feeding and spawning areas, refuges for juvenile fish, and other essential environmental services.

The presence of metals in the surface water and sediment can impair the local fish community in two general ways: (1) mortality of sensitive early-life stages exposed to dissolved metals in the water column or pore water, or (2) high metal concentrations in aquatic biota via food chain uptake, which could affect reproduction and the long-term survival of the exposed fish.

As with the benthic invertebrate community, it is considered possible that mainstem Mineral Creek upstream of the confluence with South Fork Mineral Creek, and mainstem Cement Creek, may not have supported fish before large-scale mining activities started in the 19th century (Church *et al.*, 2007). However, this BERA conservatively evaluates the potential ecological risk to a hypothetical fish community in these waterways in order to assess the current conditions. The outcome of this evaluation should be interpreted in a broader context, which considers naturally altered surface water conditions.

2.4.2.2 Wildlife receptors

The Colorado Parks and Wildlife Natural Diversity Information Source was accessed online to obtain a list of known or likely species occurrence in San Juan County, CO (see **Appendix 6**). This county encompasses the Animas River upstream and downstream of Silverton.

The information below lists select bird and mammal species found in San Juan County that may obtain some or all of their food from an aquatic environment. Note, however, that it is unknown if any of these species actually inhabit the reaches of the Animas River specifically evaluated in this BERA.

Birds:

- great blue heron (*Ardea Herodias*): piscivore
- belted kingfisher (*Ceryle alcyon*): piscivore
- American dipper (*Cinclus mexicanus*): aquatic insectivore
- Canada goose (*Branta Canadensis*): herbivore
- mallard (*Anas platyrhynchos*): aquatic and terrestrial herbivore and invertivore
- common merganser (*Mergus merganser*): piscivore
- spotted sandpiper (*Actitis macularius*): benthivore
- northern rough-winged swallow (*Stelgidopteryx serripennis*): aquatic insectivore
- barn swallow (*Hirundo rustica*): aquatic insectivore

Mammals:

- American beaver (*Castor Canadensis*): herbivore
- big brown bat (*Eptesicus fuscus*): insectivore
- common muskrat (*Ondatra zibethicus*): herbivore
- mink (*Mustela vison*): carnivore, including fish and crayfish
- water shrew (*Sorex palustris*): aquatic insectivore

Four kinds of bird and mammal species were assessed in this BERA using food chain modeling to calculate metal-specific daily exposures from drinking surface water, ingesting sediment, and feeding on aquatic food items from the Animas River above and below Silverton. This BERA does not calculate exposures for wildlife receptors that might feed in mainstem Cement Creek and mainstem Mineral Creek because these two waterways do not support viable aquatic invertebrate and fish communities under current conditions and therefore cannot provide a food base. This BERA evaluates the following target wildlife receptors:

- Invertivorous birds: represented by the American dipper (*Cinclus mexicanus*)

The American dipper is a small passerine bird, which forages on the bottom of fast-moving rocky streams in mountainous regions of the western US. It dives to the bottom of the stream where it seeks out mainly aquatic insects and their larvae, but also small crustaceans (e.g.,

juvenile crayfish) or tiny fish and tadpoles. This species was selected for use in food chain modeling to represent birds, which feed on aquatic insects and benthic invertebrates. It also serves as a surrogate for the southwestern willow flycatcher, a T&E species of passerine insectivore listed for San Juan County, CO, which may or may not be present in the riparian habitat of the Animas River above or below Silverton.

- Omnivorous birds: represented by the mallard (*Anas platyrhynchos*)

The mallard is a medium-sized dabbling duck with a flexible diet consisting of aquatic and terrestrial plants (including leaves, stems, seeds, roots and tubers), but also aquatic invertebrates (e.g., crustaceans and aquatic insects), and terrestrial invertebrates (e.g., worms, snails, slugs, beetles). This species was selected for use in food chain modeling to represent avian herbivores that also have the ability to switch to an invertivorous diet, particularly during the egg-laying season.

- Piscivorous birds: represented by the belted kingfisher (*Ceryle alcyon*)

The belted kingfisher is a piscivore which feeds mostly on fish that swim near the surface or in shallow areas of ponds, lakes, rivers, and streams. Depending on food availability and season, they may also feed on other aquatic species such as crayfish, mussels, insects, and amphibians, among others. The bird catches its prey by diving head-first into the water in flight or jumping from a perch along the shoreline. This species was selected for use in food chain modeling to represent piscivorous birds.

- Herbivorous mammals: represented by the muskrat (*Ondatra zibethicus*)

The muskrat is an aquatic rodent which feeds primarily on aquatic plants such as marsh grasses, sedges, cattails, bulrushes and green algae. The herbivorous diet can be complemented by small amounts of crayfish, mollusks, fish, frogs, turtles, and young birds. This species was selected for use in food chain modeling to represent semi-aquatic herbivorous mammals.

2.4.3 Selecting assessment endpoints and measures of effect

2.4.3.1 Assessment endpoints and risk questions

The following assessment endpoints were used in this BERA to evaluate the potential risks to the aquatic receptors, and wildlife receptors feeding on aquatic food items from the Animas River above and below Silverton. A risk question was appended to each assessment endpoint.

The BERA assumed that by evaluating and protecting the assessment endpoints, all of the aquatic habitats, and the wildlife receptors feeding on them, were protected as well.

- **Maintain a stable and healthy benthic invertebrate community**: *are the metal levels in sediment and pore water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below Mineral Creek high enough to impair the benthic invertebrates in these waterways?*

- **Maintain a stable and healthy fish community**: *are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below Mineral Creek high enough to impair the fish in these waterways?*

- **Maintain stable and healthy invertivorous bird populations**: *are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy omnivorous bird populations**: *are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy piscivorous bird populations**: *are the metal levels in surface water and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

- **Maintain stable and healthy herbivorous mammal populations**: *are the metal levels in surface water, sediment, and aquatic plants high enough to impair herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

2.4.3.2 Measures of effect

<u>Assessment endpoint #1</u>:

Maintain a stable and healthy benthic invertebrate community: *Are the metal levels in sediment and pore water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below Mineral Creek high enough to impair the benthic invertebrates in these waterways?*

The BERA uses up to four measures of effect, depending on the exposure unit, to assess the potential impacts of metals to this receptor group, as follows:

1.A Compare the metal levels measured in sediment samples to sediment benchmarks.

1.B Compare the metal levels measured in field-collected pore water samples to CSWBs.

1.C Assess survival and biomass in the amphipod *Hyalella azteca* exposed in the laboratory for ten days to sediment samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

1.D Assess the benthic community structure and function based on field-collected invertebrate samples.

Assessment endpoint #2:

Maintain a stable and healthy fish community: *Are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below mainstem Mineral Creek high enough to impair the fish in these waterways?*

This BERA uses two measures of effect to assess the potential impacts of metals to this receptor group, as follows:

2.A Compare metal levels measured in surface water samples to CSWBs.

2.B Assess survival in juvenile rainbow trout (*Oncorhynchus mykiss*) exposed for 96 hours in the laboratory to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

Assessment endpoint #3:

Maintain stable and healthy invertivorous bird populations: *are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measure of effect to assess the potential impacts of metals ingested by this receptor group, as follows:

3.A Use metal concentrations measured in sediment and benthic invertebrates in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and benthic invertebrates, and compare these EDDs to avian TRVs.

Assessment endpoint #4:

Maintain stable and healthy omnivorous bird populations: *are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measure of effect to assess the potential impacts of metals ingested by this receptor group, as follows:

4.A Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use the estimated plant residues and the measured benthic invertebrate residues in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and food, and compare these EDDs to avian TRVs.

Assessment endpoint #5:

Maintain stable and healthy piscivorous bird populations: *are the metal levels in surface water and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measurement endpoint to assess the potential impacts of metals ingested by this receptor group:

5.A Use metal concentrations measured in sediment samples to estimate metal residues in fish; use food chain modeling to calculate metal-specific EDDs from ingesting surface water and fish, and compare these EDDs to avian TRVs.

Assessment endpoint #6:

Maintain stable and healthy herbivorous mammal populations: *are the metal levels in surface water, sediment, and aquatic plants high enough to impair herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

This BERA uses one measurement endpoint to assess the potential impacts of metals ingested by this receptor group:

6.A Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment, and aquatic plants, and compare these EDDs to mammalian TRVs.

2.5 Conceptual Site Model

The CSM provides the foundation of a problem formulation. The CSM was developed based on knowledge of natural and man-made sources, contaminants, complete exposure pathways, and likely ecological receptors. The model shows how metals move from the contaminant sources through the exposure media to the receptors. **Figure 2.1** presents the CSM for this BERA.

The primary sources of contamination to the local water ways consists of water which has come into contact with local rock, either naturally or as a result of mining activities, such as through the creation of adits. Sulfuric acid is released when water and oxygen interact with the sulfide-rich mine wastes, host rock, or vein rock. This acid dissolves metals that enter the waterways as surface runoff, or via the groundwater (e.g., seeps; adits). Fine tailings material may also be present in the substrate of the waterways as a result of entrainment further upstream in the watershed. This material can serve as a secondary source of metals, mainly to the benthic invertebrate community.

The surface waters in mainstem Cement Creek and mainstem Mineral Creeks carry high loads of total and dissolved metals, and high acidity, into the Animas River in the vicinity of Silverton, even though substantial dilutions take place at that point. The benthic invertebrates and fish in the affected waterways become exposed to mine-derived and naturally-high levels of metals mainly by direct contact with surface water, sediment or pore water, whereas the wildlife receptors foraging in the Animas River become exposed by ingesting surface water and sediment, consuming fish, aquatic invertebrates, or plants. The current metal levels are high enough, and pH levels low enough, to cause mainstem Cement Creek and mainstem Mineral Creek to be essentially devoid of aquatic life, and to potentially affect aquatic life in the Animas River at and below Silverton.

3.0 COPEC SELECTION & BASELINE ECOLOGICAL EFFECTS EVALUATION

3.1 Matrices of concern

This BERA uses the analytical data from samples of surface water, sediment, pore water, and benthic invertebrates to assess current exposures to aquatic, community-level receptors and wildlife receptors.

3.2 Total metals versus dissolved metals

The surface water data consisted of both total metals (i.e., unfiltered) and dissolved metals (i.e., filtered), whereas the pore water data consisted only of dissolved metals.

- With two exceptions, exposures of the aquatic, community-level receptors to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek and the three Animas River reaches were quantified using dissolved metals because these data represented the fraction which is bioavailable, and hence toxic, to aquatic invertebrates and fish. The exceptions were Al and Fe in surface water, for which the chronic benchmark (Fe) or the hardness-dependent equation needed to derive a chronic benchmark (Al) were based on total recoverable metals (Colorado Department of Public Health and the Environment [CDPHE], 2013).

- Exposures of the benthic invertebrate community to pore water samples collected from the Animas River above mainstem Cement Creek, the Animas River below mainstem Mineral Creek, and in mainstem Mineral Creek were quantified using only dissolved metals, even for Al and Fe. The reason is that none of the pore water samples were analyzed for total metals. Additionally, none of the pore water samples were measured for pH. This variable is one of the two additional input parameters (the other one is hardness, which was available) required to derive a chronic benchmark for total Al using the CDPHE (2013) equation. As a result, the toxicity of Al in the pore water samples was determined by comparing dissolved Al levels to the standard chronic Al benchmark of 87 µg/L.

- The wildlife exposures associated with ingesting surface water from the Animas River were quantified using total metals concentrations. The reason is that the full amount of metal in water ingested while drinking becomes part of the daily dose of a wildlife receptor.

These different approaches ensured that the exposure of each receptor group to surface water was properly accounted for to the best ability of the available data.

3.3 Toxicity benchmarks

3.3.1 Surface water benchmarks

The metals concentrations measured in surface water and pore water samples were compared to surface water screening benchmarks to select COPECs for the aquatic, community-level receptors. The Colorado State Water Quality Criteria (WQC) regulation (CDPHE, 2013) was the primary source of surface water benchmarks used in the evaluation.

The metal concentrations were compared to the chronic WQC (referred to as the Criteria Continuous Concentration [CCC]). The WQC for Al, Ag, Cd, Cr, Cu, Mn, Pb, Ni, and Zn were adjusted for hardness in order to calculate hardness-specific benchmarks. Chronic toxicity thresholds summarized by Buchman (2008) were used when Colorado State WQC were not available.

Table 3.1 summarizes the CSWBs and hardness-dependent equations used to select the surface water COPECs for aquatic, community-level receptors and for use in the subsequent risk evaluation.

3.3.2 Sediment benchmarks

The metal concentrations measured in bulk sediment samples collected from the Site were compared to no effect sediment benchmarks, to select COPECs for the benthic invertebrate receptors. The Threshold Effect Concentrations (TECs), which consisted of the Threshold Effect Level (TEL), the TEL for *Hyalella azteca* in 28-day tests (TEL-HA28), the Effect Range-Low (ER-L) and the Lowest Effect Level (LEL), were the sources of sediment benchmarks used in COPEC selection.

The following hierarchy (in order of preference) was used to obtain these no-effect sediment benchmarks:

- MacDonald *et al.* (2000); consensus-based TECs,
- Ingersoll *et al.* (1996); TELs,
- Long *et al.* (1995); ER-Ls, and
- Thompson *et al*. (2005); LELs.

The Long et al. (1995) reference was included, even though its benchmarks pertain specifically to estuarine and marine environments. The reason is that this reference was the only one that provided a sediment benchmark for Ag.

In addition, following the COPEC selection process, the metals in sediment were further evaluated using effect sediment benchmarks which consisted of Probable Effect Concentrations (PECs), the Probable Effect Level (PEL), the Effect Range-Median (ER-M), and the Severe Effect Level (SEL).

The following hierarchy (in order of preference) was used to obtain these effect sediment benchmarks:

- MacDonald *et al.* (2000); consensus-based PECs,
- Ingersoll *et al.* (1996); PELs,
- Long *et al.* (1995); ER-Ms, and
- Thompson *et al.* (2005); SELs.

Table 3.1 summarizes the no-effect sediment benchmarks used to select the sediment COPECs for benthic invertebrates and the effect sediment benchmarks that were also used in the subsequent risk evaluation. The shaded values represent the sediment benchmarks retained for these purposes.

3.4 TRVs for wildlife receptors

The following hierarchy was used to obtain the mammalian and avian no effect TRVs for comparison to the EDDs in the wildlife risk characterization:

- EPA Eco SSLs (http://www.epa.gov/ecotox/ecossl/).

- Sample *et al.*, 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf (values represent the test species).

Effect TRVs for birds and mammals were obtained from Table C-8 in Appendix C (available at www.epa.gov/reg3hscd/npl/PASFN0305521/fsr/All_Appendix_C.pdf) of the May 2011 *Final Remedial Investigation and Feasibility Study for the Lower Darby Creek Area (LDCA) Site, Delaware and Philadelphia Counties, Pennsylvania.*

Tables 3.2 and 3.3 present the no-effect and effect TRVs for birds and mammals, respectively. These two tables provide TRVs only for those metals identified as "important bioaccumulative compounds" in Table 4-2 of EPA (2000).

3.5 COPEC selection process

The surface water and sediment COPECs are presented in the next subsections. Ca, Mg, K, and Na were automatically eliminated as COPECs for aquatic community receptors and wildlife receptors because these four compounds represent essential physiological electrolytes that are not expected to cause toxicity at prevailing concentrations (EPA, 2001).

The surface water samples collected during the three flow periods (i.e., pre-runoff period [February to April], runoff period [May and June], and post-runoff period [July through November]) were combined into one dataset for each of the five EUs. Hence, COPECs were selected for individual EUs across the three flow periods. This approach was conservative

because the highest concentrations measured during the pre-runoff, runoff, and post-runoff periods were used to select the COPECs that would apply to all three flow periods.

3.5.1 Surface water COPECs for aquatic community-level receptors

The surface water COPEC selection process for aquatic community-level receptors evaluated the metals in two ways, depending on whether the toxicity of a metal was hardness-independent or hardness-dependent, as follows:

- Hardness-independent surface water toxicity

The toxicity of As, Be, Fe, and Se in surface water does not depend on hardness. COPEC selection for these four compounds consisted of comparing maximum dissolved (As, Be, and Se) or total (Fe) metal concentrations measured in surface water samples to the published chronic surface water screening benchmarks.

- Hardness-dependent surface water toxicity

CDPHE (2013) states that the toxicity of Ag, Al, Cd, Cr, Cu, Mn, Ni, Pb, and Zn depend on surface water hardness (in addition to pH for Al; see CDPHE, 2013 for details). It would have been inaccurate to automatically select the highest concentration of each of these metals to select surface water COPECs because a lesser concentration could be more toxic if the hardness was much lower.

Under those circumstances, the only reliable way to identify the most toxic surface water concentration was to: (1) calculate hardness-adjusted HQs for each target metal in each surface water sample (note: A hardness-adjusted HQ was obtained by dividing a metal concentration by its toxicity benchmark adjusted for the hardness of the water sample associated with that metal), (2) identify the highest HQ for a target metal in all of the surface water samples, and (3) select the metal concentration associated with that HQ as the concentration for use in COPEC selection.

This approach ensured that the metal concentration associated with the highest HQ was used in the surface water COPEC selection process. **Appendix 7** summarizes the hardness-adjusted HQs for the hardness-dependent metals measured in the surface water samples.

Surface water COPECs for mainstem Mineral Creek

Mainstem Mineral Creek was sampled at one location (M34), for the purpose of this BERA. Twenty four surface water samples were collected between May 2009 and September 2014. **Table 3.4** summarizes the COPEC selection process at this EU.

- As, Cr, Cu, Pb, Mn, Ni, and Se were eliminated because their maximum concentrations did not exceed their respective CSWBs.

- pH, Al, Be, Cd, Fe, Ag, and Zn were retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceeded their respective chronic surface water benchmarks.

Be was retained as a COPEC even though it was not present above its analytical DL in any of the surface water samples collected from this EU. It was flagged because half of the highest DL exceeded the CSWB. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for mainstem Cement Creek

Mainstem Cement Creek was sampled at two locations (i.e., CC48 and CC49) for the purpose of this BERA. However, except for a single sample collected at CC49 in October of 2012, all the remaining surface water samples were collected from CC48 between May 2009 and September 2014. **Table 3.5** summarizes the COPEC-selection process at this EU.

- As, Cr, Ni, and Se were eliminated because the maximum concentrations did not exceed the respective CSWBs.

- pH, Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn were retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceeded the respective CSWBs.

Ag was retained as a COPEC even though it was not present above its analytical DL in any of the surface water samples collected from this EU. It was flagged as a COPEC because half of the highest DL exceeded its CSWB. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at six locations between May 2009 and September 2014. However, over half of the samples were collected at sampling location A68. **Table 3.6** summarizes the COPEC selection process at this EU.

- As, Cr, Ni, and Se were eliminated because the maximum concentrations did not exceed the respective CSWBs.

- pH, Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn were retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceeded the respective CSWBs.

Be and Ag were retained as COPECs even though neither analyte was present above the analytical DL in any of the surface water samples collected from this EU. They were flagged because half of the highest DLs exceeded their CSWBs. Both analytes are discussed as uncertainties in the risk characterization because they cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River between mainstem Cement Creek and mainstem Mineral Creek

This reach of the Animas River was sampled only once at two locations in October of 2012. **Table 3.7** summarizes the COPEC selection process at this EU.

- As, Cr, Pb, Ni, Se, and Ag were eliminated because the maximum concentrations did not exceed the respective CSWBs.

- pH, Al, Be, Cd, Cu, Fe, Mn, and Zn were retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceeded the respective CSWBs.

Be was retained as a COPEC even though it was not present above its analytical DL in either of the two surface water samples collected from this EU. It was flagged because half of the highest DL exceeded the CSWB. This analyte is discussed as an uncertainty in the risk characterization because it cannot be further evaluated quantitatively.

Surface water COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at seven locations between May 2009 and September 2014. However, about half of the samples came from sampling location A72. **Table 3.8** summarizes the COPEC-selection process at this EU.

- As, Cr, Pb, Ni, and Se were eliminated because the maximum concentrations did not exceed the respective CSWBs.

- pH, Al, Be, Cd, Cu, Fe, Mn, Ag, and Zn were retained as COPECs for further evaluation because the concentrations associated with the highest HQs exceeded the respective CSWBs.

Be and Ag were retained as COPECs even though neither analyte was present above its DL in any of the surface water samples collected from this EU. They were flagged because half of the highest DL exceeded the CSWBs. Both analytes are discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Table 3.9 summarizes all of the surface water COPECs for the aquatic, community-level receptors in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River retained for further evaluation.

3.5.2 Sediment COPECs for benthic invertebrates

The sediment COPEC selection process for benthic community-level receptors was based on comparing maximum concentrations measured in bulk sediment samples collected from

mainstem Mineral Creek, mainstem Cement Creek, and two of the three reaches of the Animas River against the no-effect sediment benchmarks identified in **Table 3.1**. Note that no sediment samples were collected from the Animas River flowing between mainstem Cement and Mineral Creeks. The sediment data from the Animas River were combined by reach to select the COPECs.

Sediment COPECs for mainstem Mineral Creek

This waterway was sampled twice for sediment in October 2012 and September 2014 at sampling location CC49. **Table 3.10** summarizes the COPEC selection process at this EU.

- Cr, Fe, Hg, Ni, and Ag were eliminated from further consideration because the maximum concentrations did not exceed the respective sediment screening benchmarks.

- Al, As, Cd, Cu, Pb, Mn, Se, and Zn were retained as COPECs for further evaluation because the maximum concentrations exceeded the respective sediment screening benchmarks.

Be was retained as a COPEC even though it was not present above its analytical DL in the sediment sample collected from this EU. This analyte was flagged as a COPEC because it lacked a screening benchmark. It is as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Sediment COPECs for mainstem Cement Creek

This waterway was sampled once for sediment in October 2012 at sampling location CC49. **Table 3.11** summarizes the COPEC selection process at this EU.

- Al, Cd, Cr, Fe, Mn, Hg, Ni, and Se were eliminated from further consideration because the maximum concentrations did not exceed the respective sediment screening benchmarks.

- As, Cu, Pb, Ag, and Zn were retained as COPECs for further evaluation because the maximum concentrations exceeded the respective sediment screening benchmarks.

Be was retained as a COPEC even though it was not present above its analytical DL in the sediment sample collected from this EU. This analyte was flagged as a COPEC because it lacked a screening benchmark. It is discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Sediment COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at six locations between May 2012 and September 2014. **Table 3.12** summarizes the COPEC selection process at this EU.

- Al, Cr, Fe, and Ni were eliminated as COPECs because the maximum concentrations fell below the screening benchmarks.

- As, Cd, Cu, Pb, Mn, Mercury (Hg), Se, Ag, and Zn were retained as COPECs because the maximum concentrations exceeded the screening benchmarks.

Be was also retained as COPECs because it lacked a screening benchmark. This analyte is discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Sediment COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at six locations between May 2012 and September 2014. **Table 3.13** summarizes the COPEC selection process at this EU.

- Cr, Fe, and Hg were eliminated as COPECs because the maximum concentrations fell below the screening benchmarks.

- Al, As, Cd, Cu, Pb, Mn, Ni, Se, Ag, and Zn were retained as COPECs because the maximum concentrations exceeded the screening benchmarks.

Be was also retained as a COPEC because it lacked a screening benchmark. This analyte is discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Table 3.14 summarizes all of the sediment COPECs for the benthic invertebrate community in mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River that were retained for further evaluation.

3.5.3 Pore water COPECs for benthic invertebrates

Similar to surface water, the pore water COPEC selection process evaluated the metals in two ways, depending on whether the toxicity of a metal was hardness-independent or hardness-dependent, as follows:

- Hardness-independent metals

The toxicity of As, Be, Fe, and Se in pore water does not depend on hardness. Pore water COPEC selection for these four compounds consisted of comparing maximum dissolved metal concentrations measured in the pore water samples to chronic surface water screening benchmarks.

- Hardness-dependent metals

CDPHE (2013) states that the toxicity of Ag, Al, Cd, Cr, Cu, Mn, Ni, Pb, and Zn in water depends on surface water hardness (in addition to pH for Al; see CDPHE, 2013 for details. Note, however, that pH was not measured in the pore water samples and that the COPEC selection process for Al was therefore based on comparing dissolved Al concentrations against the standard Al CSWB of 87 μg/L). It would have been inaccurate to automatically retain the highest concentration of each of these metals to select pore water COPECs because a lesser concentration could be more toxic if the hardness was much lower.

Under those circumstances, the only reliable way to identify the most toxic pore water concentration was to: (1) calculate hardness-adjusted HQs for each target metal in each pore water sample, (2) identify the highest HQ for a target metal in all of the pore water samples, and (3) select the metal concentration associated with that HQ as the concentration to select pore water COPECs.

This approach ensured that the metal concentration associated with the highest HQ was used in the pore water COPEC selection process. **Appendix 8** summarizes the hardness-adjusted HQs for the hardness-dependent metals measured in the pore water samples. Pore water COPECs were identified for the Animas River above mainstem Cement Creek, the Animas River below mainstem Mineral Creek, and mainstem Mineral Creek. Pore water samples were not collected from the Animas River flowing between mainstem Cement and Mineral Creeks, or from mainstem Cement Creeks.

Pore water COPECs for the Animas River above mainstem Cement Creek

This reach of the Animas River was sampled at up to six locations in April 2014 and September 2014. **Table 3.15** summarizes the COPEC selection process at this EU.

- As, Cr, Fe, and Ni were eliminated as COPECs because the maximum concentrations fell below the screening benchmarks.
- Al, Be, Cd, Cu, Pb, Mn, Se, Ag, and Zn were retained as COPECs because the concentrations associated with the highest HQs exceeded the screening benchmarks.

Be, Se, and Ag were retained as COPECs even though they were not present above their DLs in any of the pore water samples collected from this EU. They were flagged because half of the highest DL exceeded the CSWBs. These three analytes are discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Pore water COPECs for the Animas River below mainstem Mineral Creek

This reach of the Animas River was sampled at up to five locations in April 2014 and September 2014. **Table 3.16** summarizes the COPEC selection process at this EU.

- As, Cr, Cu, Pb, Ni, and Se were eliminated as COPECs because the concentrations associated with the highest HQs fell below the screening benchmarks.

- Al, Be, Cd, Fe, Mn, Ag, and Zn were retained as COPECs because their maximum concentrations exceeded the screening benchmarks.

Be and Ag were retained as COPECs even though they were not present above the DLs in any of the nine pore water samples collected from this reach. They were flagged because half of the highest DL exceeded the CSWBs. These two analytes are discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Pore water COPECs for mainstem Mineral Creek

Mainstem Mineral Creek was sampled once in September 2014. **Table 3.17** summarizes the COPEC selection process at this EU.

- Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Se and Zn were eliminated as COPECs because the maximum concentrations fell below the screening benchmarks.

- Be and Ag were retained as COPECs because the maximum concentrations exceeded the screening benchmarks.

Be and Ag were retained as COPECs even though they were not present above the DLs in the one pore water sample collected from this EU. They were flagged because half the DL exceeded the CSWB. These two analytes are discussed as an uncertainty in the risk characterization, but cannot be further evaluated quantitatively.

Table 3.18 summarizes all of the pore water COPECs for the benthic invertebrate community in mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek retained for further evaluation.

3.5.4 COPECs for wildlife receptors

The approaches outlined above did not apply to the four wildlife receptors evaluated using food chain modeling. The reason was that the exposures were not from direct contact with surface water or sediment, but from ingesting surface water, sediment, and aquatic food items. Therefore, a metal was automatically retained as a wildlife COPEC for evaluation in the food chain models if it met the following two conditions: 1) it was present above its analytical DL in at least one surface water sample or one sediment sample, and 2) it was identified as an "important bioaccumulative compound" in Table 4-2 in EPA, 2000. *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment, Status and needs.* EPA-823-R-00-001, February 2000. Metals that fell into the bioaccumulative category consisted of As, Cd, Hexavalent Chromium (CrVI), Cu, Pb, methylmercury (MeHg), Ni, Se, Ag, and Zn. Note that CrVI and MeHg were not expected to be present in surface water and sediment from the Animas River. However, as a conservative measure, oxidized Cr (i.e., CrIII) and inorganic Hg, if detected, were retained for evaluation in the wildlife food chain models.

3.6 Toxicity testing

3.6.1 Surface water

EPA Region 8 performed three sets of surface water toxicity tests in October 2012, November 2012, and April 2013 at the Golden, CO laboratory. These tests consisted of exposing juvenile rainbow trout (*Oncorhynchus mykiss*) for 96 hours at 12°C to undiluted samples from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek, and to various dilutions. **Appendices 9.a and 9.b** provide more details on the study design and rationale.

3.6.1.1 Surface Water Collection and dilutions

October 2012

<u>Site-specific toxicity testing</u>:

Surface water samples were collected in October 2012 from six sampling locations, as follows (see **Figure 1.1 and 1.2**):

- *Animas River above mainstem Cement Creek*: sampling locations A56 ("upstream") and A68.

- *Animas River below mainstem Mineral Creek*: sampling locations A72, A73B, A75B, and BB.

These surface water samples represented composites collected in the mid-water column across the width of the Animas River. They were tested undiluted for acute toxicity.

<u>Serial dilution toxicity testing</u>:

Flow-weighted surface water samples were also collected from mainstem Mineral Creek (sampling location M34) and mainstem Cement Creek (sampling location CC48). The samples were, (a) combined in a 61% (M34) + 39% (CC48) ratio (M34/CC48), (b) diluted using water from "upstream" sampling location A56 to generate water representing 6.25%, 12.5%, 25%, 50% and 100% CC48/M34, and (c) tested for acute toxicity.

Finally, the flow-weighted M34/CC48 surface water sample was diluted using water from sampling locations A68 to generate water representing 6.25%, 12.5%, 25%, and 50% M34/CC48 samples and then tested for acute toxicity.

November 2012

Surface water samples were collected in November 2012 from four sampling locations, as follows:

- *Animas River above mainstem Cement Creek*: sampling location A68
- *Animas River below mainstem Mineral Creek*: sampling location A72
- *Mainstem Cement Creek*: sampling location CC48
- *Mainstem Mineral Creek*: sampling location M34

All these surface water samples represented composite samples collected in the mid-water column across the width of each of the waterways.

Site-specific toxicity testing

Surface water from sampling locations M34, A68 and A72 were tested undiluted for acute toxicity.

Serial dilution testing

Surface water from sampling location A68 was used as a diluent to generate dilutions of surface water from sampling locations A72, as follows: 0% (full strength A68 water), 5%, 10%, 25%, 50%, 75%, and 100% (full strength A72 water). Each of these dilutions was then tested for acute toxicity.

Surface water from sampling location A68 was used as a diluent to generate dilutions of surface water collected from sampling location CC48, as follows: 0% (full strength A68), 1%, 3%, 6%, 12%, 25%, and 50% (50% CC48 water). Each of these dilutions was then tested for acute toxicity.

Surface water from sampling location A68 was used as a diluent to generate dilutions of a flow-weighted mixture of water samples collected from M34 and CC48 (M34/CC48), as follows: 0% (full strength A68 water), 4%, 9%, 20%, 40%, 65%, and 85% (85% of M34/CC48 flow-weighted mixture water). Each of these dilutions was then tested for acute toxicity.

April 2013

Site-specific toxicity testing:

Surface water samples were collected in April 2013 from six sampling locations, as follows:

- *Animas River above mainstem Cement Creek*: sampling location A68

- *Animas River below mainstem Mineral Creek*: sampling locations A72, A73, A73B, and A75B

- *Mainstem Mineral Creek*: sampling location M34

All these surface water samples represented composite samples collected in the mid-water column across the width of each waterway. They were tested full-strength (i.e., undiluted) for acute toxicity.

Serial dilution toxicity testing

Animas River water (A72) diluted by Hard Reconstituted Water (HRW)

The surface water sample collected from sampling location A72 was serially diluted with HRW to determine what dilutions of site water would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in Animas River A72 surface water samples of 12%, 25%, 35%, 50%, 75%, and 88% strength.

Combined Mineral Creek and Cement Creek water (M34/CC48) diluted by A68 and HRW

The flow-weighted mixed surface water sample M34/CC48 was serially diluted either with Animas River water collected at sampling location A68 or with HRW to determine what dilutions would cause acute toxicity to juvenile rainbow trout. The serial dilutions resulted in M34/CC48 samples of 25%, 50%, 75%, 80%, 90%, and 95% strength (using water from sampling location A68 as diluent) or 25%, 50%, 75%, 90%, and 95% strength (using HRW as diluent).

3.6.1.2 Interpretation of the surface water toxicity test results

October 2012

Table 3.19 summarizes the outcome of the October 2012 toxicity tests.

Site-specific acute toxicity testing:

100% of the juvenile rainbow trout exposed for 96 hours to undiluted Animas River water survived at sampling locations A56 ("upstream" location), A68, A73B, A75B, and BB. On the other hand, complete mortality was observed in juvenile rainbow trout exposed for 96 hours to undiluted Animas River water collected from A72.

These results showed that at least 3,500 ft of the Animas River below mainstem Mineral Creek up to sample location A72 was acutely toxic to juvenile rainbow trout in October of 2012. Sampling location A73B, situated about 5.9 miles downstream from sampling location A72, was not acutely toxic during that same period. This finding showed that ongoing dilution of the

Animas River with surface water from various drainages flowing into the Animas River downstream of sampling location A72 mitigated the acute toxicity to juvenile rainbow trout.

<u>Serial dilution acute toxicity testing</u>

A flow-weighted sample of M34/CC48 was serially diluted either with surface water collected from sampling location A56 ("upstream" location) or from sampling location A68. The results showed that the M34/CC48 mixture was acutely toxic to juvenile rainbow trout only when it was tested undiluted (acute mortality was not significant when the M34/CC48 mixture was diluted 50% with A56 water). The M34/CC48 mixture was also acutely toxic when it was diluted 50% with A68 water.

November 2012

Table 3.20 summarizes the outcome of the November 2012 acute toxicity tests.

<u>Site-specific acute toxicity testing</u>:

Ninety-two and a half percent of the juvenile rainbow trout survived a 96-hour exposure to undiluted Animas River water collected from sampling location A68. On the other hand, all juvenile rainbow trout died after 96 hours of exposure to surface water collected from sampling location M34 on mainstem Mineral Creek. Additionally, only 2.5% of juvenile rainbow trout survived a 96-hour exposure to surface water collected from sampling location A72 on the Animas River about 3,500 ft below mainstem Mineral Creek.

These results showed that surface water from mainstem Mineral Creek and from the Animas River down to at least sampling location A72 was acutely toxic to juvenile rainbow trout in November of 2012. The testing structure did not allow for an estimation of how much further downstream from A72 this acute toxicity would be expressed. However, the serial dilution of surface water from sampling location A72 with surface water from sampling location A68 (see below) showed that this water was not acutely toxic to juvenile rainbow trout when tested at a strength of 75%. This evidence suggested that a relatively small amount of dilution of the Animas River surface water with uncontaminated water further downstream would be expected to mitigate the acute toxicity measured at sampling location A72.

<u>Serial dilution acute toxicity testing</u>

Surface water collected from sampling location A72 was serially diluted with surface water collected further upstream on the Animas River at sampling location A68. Survival of juvenile rainbow trout acutely exposed to the surface water sample collected at A72 was not significantly different from the control when that sample was at 75% strength. Only undiluted A72 sample resulted in acute toxicity.

Surface water from sampling location CC48 resulted in 100% mortality when it was diluted 50% using water from sampling location A68 as the diluent. The CC48 surface water had to be diluted by a factor of four using A68 water as the diluent in order to mitigate the acutely toxic effects.

A similar pattern was observed using the flow-weighted M34/CC48 sample. This sample at 40% strength, using surface water from sampling location A68 as the diluent, was not acutely toxic to juvenile rainbow trout, whereas mortality was 100% when the M34/CC48 sample was tested at 65% strength using the same diluent source.

April 2013

Table 3.21 summarizes the outcome of the April 2013 acute toxicity tests.

<u>Site-specific acute toxicity testing</u>:

Survival in juvenile rainbow trout exposed to Animas River surface water from sampling locations A73 (98%), A73B (97.5%), and A75B (100%) was not significantly different from the controls. On the other hand, survival was significantly reduced in Animas River surface water from sampling location A68 (67.5% survival) and A72 (0% survival), and in mainstem Mineral Creek from location M34 (15% survival).

These results showed that at least 3,500 ft of the Animas River below mainstem Mineral Creek was acutely toxic to juvenile rainbow trout in April of 2013. Sampling location A73, situated about 5.9 miles downstream from sampling location A72, was not acutely toxic during that same period. This finding showed that ongoing dilution of the Animas River with surface water from various gulches and creeks flowing into the Animas River downstream of sampling location A72 mitigated the acute toxicity to juvenile rainbow trout.

<u>Serial dilution acute toxicity testing</u>:

Survival in juvenile rainbow trout exposed for 96 hours to Animas River surface water from sampling location A72 was not affected up to sample strength of 88% when HRW was used as the diluent. The data suggested that a relatively small amount of dilution with uncontaminated water removed the acute toxicity measured in full-strength surface water from sampling location A72. This conclusion is tempered by the fact that the diluent was not Animas River water collected upstream of the confluence with mainstem Mineral Creek. Rather, HRW was used as the diluent, which may have affected the toxicity of the hardness-dependent metals present in the A72 sample.

Seasonal patterns in acute toxicity to juvenile rainbow trout

Table 3.22 summarizes survival in juvenile rainbow trout acutely exposed to undiluted surface water samples in October 2012, November 2012, and April 2013.

The patterns can be interpreted as follows:

- Sample location A68 is upstream of the confluence with mainstem Cement Creek. Acute toxicity to juvenile rainbow trout was not present in surface water samples collected from this location in October and November 2012, but was observed in April 2013. It is not known if the source of this toxicity originated at the Mayflower Mill or further upstream since surface water from sampling location A56 ("upstream" location) was not tested for acute toxicity in April 2013.

- The surface water samples collected from sampling location A72 in October 2012, November 2012, and April 2013 were uniformly acutely toxic to juvenile rainbow trout. This toxicity most likely originated from mainstem Cement Creek and mainstem Mineral Creek, both of which independently showed severe acute toxicity in November 2012 and April 2013.

- The test data showed that acute toxicity to juvenile rainbow trout was consistently present at sampling location A72 (i.e., about 3,500 ft below the confluence with mainstem Mineral Creek) but was consistently absent at sampling locations A73/A73B (i.e., about 5.9 miles downstream).

3.6.2 Sediment toxicity testing

Two sediment toxicity tests were performed in December 2012 and November 2014 at the EPA regional laboratory in Golden, CO. The tests consisted of exposing juvenile amphipods (*Hyalella azteca*) for ten days at 23°C to sediment samples collected from the Animas River (A56 ["upstream" location], A60, A68, A72, A73, A73B, A75D, A75B, and BB), mainstem Cement Creek (CC49), and mainstem Mineral Creek (M34). The test endpoints consisted of survival and biomass. **Appendices 10.a and 10.b** provide details on the study design and rationale.

"Biomass" was defined as the total dw of the surviving organisms across replicates in a sediment sample at the end of the test divided by the number of organisms introduced in that sample at the start of the test. This measure was sensitive to mortality because death reduces the number of remaining organisms, which thereby decreases the final combined weight of the survivors at the end of the test, even if the individual survivors maintained or gained weight.

Table 3.23 provides the results of the two sediment toxicity tests. Note that the responses measured in both tests were compared to the laboratory control sample, instead of a Site-specific reference sample. The reason is that the sediment collected in the Animas River upstream of

location A60 for use as a reference (i.e., at location A56) showed severe effects and therefore did only represented impacted conditions. The results of the two tests can be summarized as follows:

- The laboratory control samples in the December 2012 and November 2014 tests showed 97.5% and 92.5% survival, respectively, with measureable growth in both tests. These responses met the two test acceptability criteria, namely over 80% survival plus measureable growth after ten days of exposure. Hence, the results of both tests were acceptable for use in decision making.

- Survival in the December 2012 test in sediment samples collected from locations A56, A68, A72, A73B, A75B, BB, CC49, and M34 were significantly lower compared to the laboratory control sample. Survival in the Animas River sediment samples during the November 2014 test was statistically lower than the laboratory control sample only at location A56 (note: CC49, M34, A73B, and A75B were not tested for toxicity in November 2014).

- Biomass in both the December 2012 and November 2014 tests was significantly lower at all sample locations compared to the laboratory control.

3.6.3 Benthic invertebrate survey

Macroinvertebrate samples were collected in September 2014 from seven locations on the Animas River above mainstem Cement Creek (i.e., A56 ["upstream"], A60, and A68) and below mainstem Mineral Creek (i.e., A72, A73, A75D and BB). One sample each was also collected from the mouth of mainstem Cement Creek (i.e., CC49) and the mouth of mainstem Mineral Creek (i.e., M34).

The field samplers submerged a modified rectangular kick net and used their feet to vigorously disturb a one-square meter of substrate immediately upstream of the net. This collection method was used at all sampling locations due to the primarily boulder and cobble nature of the Animas River substrate. Efforts were made to collect as many organisms as possible with the goal of collecting one gram of dw material for tissue residue analysis.

The benthic invertebrate samples were preserved in ethanol in the field and brought back to the laboratory for counting and species identification prior to chemical analysis. The data were reported as 300-count subsamples (based on protocols for Mobile Metal Ions [MMI] calculation provided by CDPHE). **Appendix 11** provides the raw counts and summarizes the community data as follows (note: a subset of the measures listed below are identified with an asterisk and are provided in **Table 3.24** by sampling location):

- Total number of organisms (# per sample)
- *Number of taxa per sample
- *Shannon-Weaver Diversity (H')
- *Hilsenhoff Biotic Index (HBI)
- *Total # of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa

- *EPT Index (% of total number of taxa)
- *Ephemeroptera abundance (% of total number)
- # of Ephemeroptera (mayflies) taxa
- # of Plecoptera (stoneflies) taxa
- # of Trichoptera (caddisflies) taxa
- *% EPT (% of total number)
- *# of intolerant taxa
- *Tolerant organisms (% of total number)
- Dominant taxon (% of total number)
- *Filterers (% of total number)
- *Scrapers (% of total number)
- # Clinger Taxa
- *Clingers (% of Total Number)

Shannon-Weaver Diversity Index (H')

The *Shannon-Weaver Diversity Index* determines species diversity. This index calculates the number of different species in a sample (species richness), and the proportion of individuals of a particular species compared to the number of individuals of other species in the sample. This comparison shows how rare or common a species is in a group. The index is calculated as follows:

$$H' = -\sum_{i=1}^{s} (P_i * \ln P_i)$$

where:

H' = the Shannon diversity index
P_i = fraction of the sample consisting of species i (i.e., the proportion of a species i relative to the total number of species present in a sample)
S = numbers of species present

A high H' represents a diverse and evenly-distributed community. A low H' represents a less diverse community. An H' of zero represents a community containing a single species.

The Hilsendorf Biotic Index (HBI)

The HBI estimates the overall tolerance of the community in a sample to organic pollution, weighted by the relative abundance of each taxonomic group. Species are assigned a tolerance value ranging between zero and ten, with zero for the most-sensitive species and ten for the least-sensitive species.

The HBI is calculated as follows:

$$HBI = \frac{\Sigma n_i \times a_i}{N}$$

where:

n	= number of specimens in taxon i
a	= tolerance value for taxon i
N	= total number of specimens in the sample

The HBI increases with decreasing water quality. Note that the taxon-specific tolerance values used in the HBI calculations were originally developed to assess organic pollution, but that the Animas River system is impacted mainly by mining-related inorganic pollution.

EPT

The EPT-related measures pertain to the number of mayfly, stonefly, and caddisfly taxa present in a sample. The EPT species are considered sensitive to pollution. As a result, impacted waters typically have lower numbers of EPT taxa than pristine waters.

Intolerant taxa

The *intolerant taxa* represent species in a sample that are intolerant to the presence of pollution. The number of intolerant taxa typically decreases with increasing contamination.

Filterers, scrapers, and clingers

These measures estimate what fraction of benthic species in a sample is represented by filter-feeders, scrapers, and clingers.

Table 3.24 summarizes the macroinvertebrate community data collected in September 2014. These data are also plotted in **Figure 3.1**. A serious constraint of the benthic survey is the lack of one or more reference locations on the Animas River upstream of Silverton to provide information on the expected benthic community structure under conditions that aren't impacted. Hence, a Site-specific "yard stick" is not available to compare against the results.

The general pattern shows a stressed benthic community at sampling locations A72 and A73 in the Animas River below the confluence with mainstem Mineral Creek. The benthic community at sampling location A75D appears robust, at least when compared to the community structure measured at sampling locations A56, A60 and A68 on the Animas River above the confluence with mainstem Cement Creek. The benthic community at sampling location CC49 in mainstem Cement Creek before its confluence with the Animas River is highly stressed and degraded. On the other hand, the benthic community at sampling location M34 in mainstem Mineral Creek before its confluence with the Animas River is generally similar to the conditions in the Animas River above the confluence with mainstem Cement Creek, and in the Animas River below mainstem Mineral Creek at sampling locations A75D and BB.

4.0 BASELINE EXPOSURE ESTIMATES

4.1 Introduction

The exposure analysis for this BERA consisted of the following two components: (a) quantify surface water, sediment, and pore water exposures to community-level receptors in mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches, and (b) perform wildlife exposure modeling in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek to calculate RME and CTE EDDs (mg/kg.bw-day).

4.2 Aquatic EUs

This BERA identifies discrete aquatic EUs to summarize the sediment, surface water, and pore water analytical data, and to quantify exposures to aquatic, community-level and wildlife receptors. The aquatic EUs were defined as follows:

- *Mainstem Cement Creek* was assessed by combining data from two sampling locations:
    - Location CC48: situated about one mile upstream of the confluence with the Animas River in Silverton. This location was sampled numerous times for surface water between May 2009 and September 2014, but not for sediment or pore water.
    - Location CC49: situated between CC48 and the confluence with the Animas River in Silverton. This location was sampled once for sediment and once for surface water in October 2012, but not for pore water.
- *Mainstem Mineral Creek* was assessed at one sampling location, as follows:
    - Location M34 is situated in mainstem Mineral Creek less than a half of a mile above the confluence with the Animas River in Silverton. This location was sampled numerous times for surface water between May 2009 and September 2014, twice for sediment in October 2012 and September 2014, and once for pore water in September 2014.
- *The Animas River above mainstem Cement Creek*:

This reach covers about two miles of the Animas River between sampling locations A60 and A68. Location A56 is situated on the Animas River about a quarter mile upgradient from A68, above the Mayflower Mill and Arrastra Creek. This location is not part of the EU and is therefore not included in the exposure calculations. A56 represents "upstream" conditions reflective of other sources of contamination further upgradient in the watershed. Location A68 is about a quarter mile upstream of the confluence with Cement Creek.

This BERA assumes that exposure to benthic invertebrates, fish, and wildlife receptors was best represented by the chemical conditions measured across all of the sampling locations in this

reach. Hence, all surface water, sediment, pore water, and benthic invertebrate tissue analytical data collected between A60 and A68 were combined into one EU.

- *The Animas River between mainstem Cement Creek and mainstem Mineral Creek*

This reach covers about one mile of the Animas River across from Silverton. Location A69A is about 2,500 ft downstream of the confluence with Cement Creek, whereas location A70B is just upstream of the confluence with Mineral Creek.

Only one surface water sample and no sediment samples were collected from each of these two sampling locations. Exposure to wildlife receptors could not be evaluated in this reach of the Animas River because sediment analytical data were not available to estimate the contaminant levels in the food items for evaluation in the food chain models.

- *The Animas River below mainstem Mineral Creek*

This reach covers about 30 river-miles between sampling locations A71B and BB. Location A71B is immediately downstream of the confluence with Mineral Creek.

This BERA assumes that exposure via surface water, sediment, and pore water to benthic invertebrates and fish in this reach of the Animas River was best represented by the chemical conditions measured at each separate sampling location. Hence, each sampling location represented its own EU for the community-level receptors. The same assumption was used to calculate exposures to the wildlife receptors. The reason is that the distance between many of the sampling locations was too great to assume that any of the receptor groups would be continuously exposed across these locations.

4.3 Seasonal effects

Surface water samples were collected throughout the year between May 2009 and September 2014 to investigate differences in metal loads across seasons. The surface water exposures for the aquatic community-level receptors were calculated at each of the sampling locations for three specific hydraulic periods across years, as follows:

- *Pre-runoff period*: February, March, and April (2010, 2011, and 2014 data combined),

- *Runoff period*: May and June (2009, 2010, 2011, 2013, and 2014 data combined), and

- *Post-runoff period*: July, August, September, October, and November (2009, 2010, 2011, 2012, and 2014 data combined). No surface water samples were collected in the months of December or January.

This approach ensured that the surface water exposures reflected the seasonal differences that existed in metal concentrations in the three waterways during the 2009 to 2014 time period.

The surface water exposures for the wildlife receptors were calculated at each EU across the three runoff periods.

4.4 Exposure point concentrations

The EPCs used in the exposure calculations consisted of RMEs and CTEs for metals in surface water, sediment, and pore water. Depending on the structure of a dataset, the RMEs represented either 95% Upper Confidence Limits (UCLs) derived using the ProUCL software, or the maximum detected values if UCLs could not be calculated due to limited datasets. If a data set was big enough to calculate 95% UCLs, but one or more of the UCLs exceeded their maximum concentrations, then the maximum concentration was used in the exposure calculations. All the CTEs represented arithmetic means, including half of the DL for non-detected compounds. Only the metals identified as COPECs in Section 3 were used to calculate EPCs.

Appendix 12 provides the ProUCL outputs (data permitting) for hardness and dissolved metals in surface water to derive EPCs for aquatic, community-level receptors. **Appendix 13** provides the ProUCL outputs for total metals in surface water (data permitting) to derive EPCs for wildlife receptors in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek. **Appendix 14** provides the ProUCL outputs for sediment (data permitting) to derive EPCs for benthic invertebrates and the wildlife receptors in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek. **Appendix 15** provides the ProUCL outputs for the pore water samples collected from the Animas River above mainstem Cement Creek (note: not enough pore water samples were collected from the individual sampling locations on mainstem Mineral Creek or from the Animas River below mainstem Mineral Creek to run ProUCL).

The Animas River above mainstem Cement Creek, and between Cement Creek and Mineral Creek, was considered as two separate EUs to calculate EPCs for community-level, aquatic receptors and the four wildlife receptors. On the other hand, the six sampling locations on the Animas River below mainstem Mineral Creek were treated as separate EUs to calculate EPCs for both the community-level, aquatic receptors and the four wildlife receptors.

The concentrations of key surface water metals to this BERA (i.e., Al, Cd, Cu, Mn, Pb, and Zn) were also assessed on a sample-by-sample basis. These analytes were evaluated by calculating HQs based on dividing the measured concentrations by the hardness-adjusted surface water benchmarks (see **Appendix 7**). The HQs were then plotted by analyte, sampling location, and hydraulic period to create "scatter plots" which provide a visual overview of spatial and temporal changes in surface water risk. The results of this evaluation are further discussed in Section 5.

4.4.1 Aquatic community-level receptors

The aquatic, community-level receptors were assumed to be directly exposed to surface water, sediment, and pore water in mainstem Cement Creek, mainstem Mineral Creek, the Animas River between mainstem Cement Creek and mainstem Mineral Creek, and at the individual sampling locations on the Animas River below mainstem Mineral Creek.

4.4.1.1 Surface water

The EPCs for dissolved metals in surface water are provided in **Table 4.1** (mainstem Mineral Creek), **Table 4.2** (mainstem Cement Creek), **Table 4.3** (Animas River above mainstem Cement Creek), and **Table 4.4** (Animas River between mainstem Cement and Mineral Creeks). Additionally, **Tables 4.5 to 4.11** provide the EPCs in surface water samples collected from sampling locations A71B, A72, A73, A73B, A75D, A75B, and BB on the Animas River below mainstem Mineral Creek.

4.4.1.2 Sediment

The EPCs for metals in sediment samples are provided in **Table 4.12** (mainstem Mineral Creek), **Table 4.13** (mainstem Cement Creek), and **Table 4.14** (Animas River above mainstem Cement Creek). Additionally, **Tables 4.15 to 4.20** provide the EPCs for metals in sediment collected from sampling locations A72, A73, A73B, A75D, A75B, and BB on the Animas River below mainstem Mineral Creek.

4.4.1.3 Pore water

The EPCs for dissolved metals in pore water samples are provided in **Table 4.21** (mainstem Mineral Creek), **Table 4.22** (Animas River above mainstem Cement Creek), and **Tables 4.23 to 4.27** for sampling locations A72, A73, A73B, A75D, and BB on the Animas River below mainstem Mineral Creek.

4.4.2 Wildlife receptors

The four wildlife receptors were assumed to forage across the two miles of Animas River above mainstem Cement Creek and at each of the individual sampling locations on the Animas River below mainstem Mineral Creek. The Animas River reach flowing between mainstem Cement and Mineral Creeks was omitted from food chain modeling because no sediment data were available to derive tissue residues needed to calculate daily doses. The two creeks were also omitted because the SLERA showed that they cannot support a healthy forage base for use by wildlife receptors.

4.4.2.1 Surface water

The EPCs for total metals in surface water used for food chain modeling are provided in **Table 4.28** (Animas River above mainstem Cement Creek), and **Tables 4.29 to 4.34** that show the

EPCs for total metals measured in surface water samples collected from sampling locations A72, A73, A73B, A75D, A75B, and BB on the Animas River below mainstem Mineral Creek.

4.4.2.2 Sediment

The EPCs for metals in sediment samples are provided in **Table 4.14** (Animas River above mainstem Cement Creek) and **Tables 4.15 to 4.20** that show the EPCs for metals measured in sediment collected from sampling locations A72, A73, A73B, A75D, A75B, and BB on the Animas River below mainstem Mineral Creek.

4.5 Wildlife food chain modeling

Section 2.4.2.2 presents the four wildlife receptors evaluated in this BERA using exposure modeling. These receptors are the American dipper (representing invertivorous birds), the mallard (representing omnivorous birds), the belted kingfisher (representing piscivorous birds), and the muskrat (representing herbivorous mammals).

Wildlife species were assumed to be exposed to COPECs in the Animas River by direct ingestion of surface water, incidental ingestion of sediment, and by feeding on contaminated food items that accumulated metals from the sediment. This BERA calculates total EDDs for each wildlife receptor to estimate their exposure using a standard exposure equation which incorporates species-specific natural history parameters.

Table 4.35 presents the intake equations for each wildlife receptor species. **Table 4.36** provides the species-specific exposure parameters (e.g., body weights, ingestion rates, relative consumption of food items, etc.), as well as the reference sources and assumptions on which these values were based. This BERA assumes two different diets for the omnivorous mallard: (a) 100% benthic invertebrates to model the diet of female mallards during the egg-laying period (the "100% diet"), and (b) a half and half diet of benthic invertebrates and plants to model the diet of mallards for the rest of the year (the "50%-50% diet").

The exposure calculations assumed that the target wildlife receptors consumed aquatic invertebrates, aquatic plants, or fish, depending on the species. **Tables 4.37, 4.38 and 4.39** provide the literature-derived regression models and uptake factors used to estimate metal concentrations in these food items based on measured COPEC levels in sediment in the Animas River. The food intake equations and the estimated COPEC tissue levels were all based on dry weight. Note that the benthic invertebrate tissue levels used in the dose calculations were measured values from organisms collected from the Animas River in September 2014, except for sampling locations A73B and A75B from which benthic invertebrates were not collected.

4.6 Wildlife EDDs

The COPEC specific wildlife EDDs were calculated using the input parameters summarized in Section 4.5. **Tables 4.40 to 4.46** provide the EDDs for the American dipper, **Tables 4.47 to 4.53** and **Tables 4.54 to 4.60** provide the EDDs for the mallard 100% diet, and 50%-50% diet, respectively. **Tables 4.61 to 4.67** provide the EDDs for the belted kingfisher, and **Tables 4.68 to 4.74** to provide the EDDs for the muskrat.

5.0 RISK CHARACTERIZATION

5.1 Introduction

The potential for ecological risk is determined during risk characterization. The exposure analysis and effects analysis described in previous sections of this report were integrated to determine the likelihood of adverse effects to the assessment endpoints, given the assumptions inherent in the analysis phase.

Table 5.1 summarizes the risk estimation approaches for each of the receptor groups evaluated in this BERA. Risk was quantified mostly using the HQ method, which compared measured exposures (i.e., surface water, sediment, and pore water EPCs) or estimated exposures (wildlife EDDs) to corresponding toxicity values (i.e., CSWBs or no-effect and effect sediment benchmarks, plus wildlife no-effect and effect TRVs).

COPEC-specific HQs were then calculated using the following general equation:

HQ = EPC or EDD/benchmark or TRV

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	Exposure Point Concentration (μg/L or mg/kg)
EDD	=	Estimated Daily Dose (mg/kg bw-day)
Benchmark	=	surface water or sediment benchmark (μg/L or mg/kg)
TRV	=	wildlife Toxicity Reference Value (mg/kg bw-day)

HQs equal to or greater than one identified a potential for ecological risk under the exposure and toxicity assumptions used in this evaluation. Besides assessing the potential impacts associated with RME and CTE surface water and sediment exposures, the risk characterization for community-level, aquatic receptor groups also viewed each surface water and sediment sample as representing an individual event in which organisms were exposed to COPECs. Hence, HQs were calculated for all available surface water and sediment samples and were plotted by sampling station and period. Risk may be acceptable if the community as a whole remains healthy and stable over time. It was assumed that community-level risks were unlikely to occur if all the HQs that were measured within a particular EU fell below one. On the other hand, community-level risks were more likely to occur if most or all of the individual HQs exceeded one. Finally, some impact may occur, but without resulting in community-level effects, if only a small portion of the HQs exceeded one.

Note that the risk characterization did not quantify “incremental risk” by subtracting reference risk from Site risk. The reason is that the Animas River above sampling location A60 is impacted by metals originating further upstream in the watershed and therefore cannot provide valid reference conditions. No reference samples were collected from either Mineral Creek or Cement Creek for use in this BERA. As such, the risks summarized in this section for each EU represent “total” risk.

Uncertainty is an inherent feature of this BERA because many assumptions were made in order to proceed with the evaluation. These assumptions affected all aspects of the assessment, including the CSM, the effects analysis, the exposure analysis, and the risk characterization. The uncertainty analysis identifies and discusses the major assumptions made in this BERA. It also determines if an assumption was likely to have overestimated or underestimated the potential for ecological risk. The end result was a balanced overview of uncertainty to help risk managers understand the full extent of potential ecological risk to receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the three Animas River reaches.

5.2 Community-level aquatic receptors - Benthic Invertebrates

Assessment endpoint 1: Maintain a stable and healthy benthic invertebrate community.
Are the metal levels in sediment from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek high enough to impair the benthic invertebrates in these waterways?

The potential for ecological risk to the benthic invertebrate community in the three waterways was assessed as follows.

5.2.1 Measurement endpoint 1A

Compare the metal levels measured in sediment samples to sediment benchmarks.

5.2.1.1 Mainstem Mineral Creek

Table 5.2 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from mainstem Mineral Creek.

All six sediment COPECs had no effect HQs greater than one. But only three of those six COPECs had an effect HQ of greater than one, with the highest HQs associated with Pb (RME effect HQ = 1.9 and CTE effect HQs = 1.4).

The data suggests that sediment in mainstem Mineral Creek close to the confluence with the Animas River presented low levels of risk to the local benthic invertebrate community.

5.2.1.2 Mainstem Cement Creek

Table 5.3 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from mainstem Cement Creek. The RME and CTE EPCs are identical to each other because only one sediment sample was collected from this EU.

All five sediment COPECs had no effect HQs that were greater than one. But only two of those five COPECs had effect HQs of greater than one, with the highest HQs associated with Pb (RME and CTE effect HQs = 2.2).

The data suggests that sediment in mainstem Mineral Creek close to the confluence with the Animas River presented low levels of risk to the local benthic invertebrate community.

5.2.1.3 Animas River

Animas River above mainstem Cement Creek

Table 5.4 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediment from the Animas River above mainstem Cement Creek. Except for Hg and Se, all seven remaining COPECs had RME or CTE effect HQs above 1.0.

The three COPECs with the highest effect HQs consisted of Pb (RME effect HQ = 13.5 and CTE effect HQ = 11.8), Mn (RME effect HQ = 10.5 and CTE effect HQ = 8.8) and Zn (RME effect HQ = 8.8 and CTE effect HQ = 6.9).

The data suggests that sediment in the Animas River above mainstem Cement Creek presented high levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A72 below mainstem Mineral Creek**

Table 5.5 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A72. Al, Cd, Ni, Se, and Ag had RME and CTE effects HQs below 1.0 and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Pb (RME effect HQ = 4.5 and CTE effect HQ = 3.7), Mn (RME effect HQ = 2.5 and CTE effect HQ = 1.8) and Zn (RME effect HQ = 1.8 and CTE effect HQ = 1.4).

The data suggested that sediment at sampling location A72 presented moderate levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A73 below mainstem Mineral Creek**

Table 5.6 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A73. Al, Ni, Se, and Ag had RME and CTE effects HQs below one and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Pb (RME effect HQ = 5.7 and CTE effect HQ = 4.0), Mn (RME effect HQ = 5.5 and CTE effect HQ = 3.6) and Zn (RME effect HQ = 3.0 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A72 presented moderate levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A73B below mainstem Mineral Creek**

Table 5.7 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A73B. Al, Cd, Ni, Se, and Ag had RME and CTE effects HQs below 1.0 and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Pb (RME effect HQ = 4.6 and CTE effect HQ = 4.2), Zn (RME effect HQ = 3.7 and CTE effect HQ = 2.4) and Mn (RME effect HQ = 3.6 and CTE effect HQ = 2.6).

The data suggested that sediment at sampling location A73B presented moderate levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A75D below mainstem Mineral Creek**

Table 5.8 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A75D. Al, As, Ni, Se, and Ag had RME and CTE effect HQs below one and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Zn (RME effect HQ = 6.1 and CTE effect HQ = 3.8), Mn (RME effect HQ = 5.3 and CTE effect HQ = 3.6) and Pb (RME effect HQ = 2.9 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A75D presented moderate levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location A75B below mainstem Mineral Creek**

Table 5.9 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location A75B. Al, Ni, Se, and Ag had RME and CTE effect HQs below one and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Zn (RME effect HQ = 11.6 and CTE effect HQ = 4.8), Pb (RME effect HQ = 3.4 and CTE effect HQ = 2.3) and Mn (RME effect HQ = 3.2 and CTE effect HQ = 2.3).

The data suggests that sediment at sampling location A75B presented high levels of risk to the local benthic invertebrate community.

- **Animas River at sampling location Bakers Bridge below mainstem Mineral Creek**

Table 5.10 presents the no effect and effect HQs for benthic invertebrates exposed to COPECs in sediments from sampling location BB. Al, As, Ni, Se, and Ag had RME and CTE effects HQs below one and were therefore of no further concern.

The three COPECs with the highest effect HQs consisted of Zn (RME effect HQ = 18.6 and CTE effect HQ = 10.1), Mn (RME effect HQ = 10.9 and CTE effect HQ = 6.2) and Cd (RME effect HQ = 3.7 and CTE effect HQ = 2.0).

The data suggests that sediment at sampling location BB presented high levels of risk to the local benthic invertebrate community.

Risk conclusion for measurement endpoint 1A

Mainstem Mineral Creek and mainstem Cement Creek had the lowest risk levels associated with metals in sediment. Pb, Mn, and Zn showed a consistent potential for risk across all the Animas River EUs. The HQ data for the three risk drivers were used to calculate a geometric mean of the no effect RME and CTE HQs, and the effect RME and CTE HQs at each of the Animas River EUs. These averaged HQs were then plotted for visualization (see **Figure 5.1**). The reach above mainstem Cement Creek represented the highest levels of risk for benthic invertebrates exposed to sediment. Risk from Pb, Mn, and Zn was still present in the Animas River below mainstem Mineral Creek, but at a lower level.

The risk from Zn in sediment increased at sampling location A75B (situated just downstream of the confluence with Cascade Creek) and was higher still at the BB sampling location situated about eleven miles further downstream. This pattern suggests the presence of a Zn source in this stretch of the Animas River or a depositional zone.

Figure 5.2 shows the sample-specific no effect and effect sediment HQs for Al, As, Cd, Cu, Pb, Mn, Ag, and Zn at each EU. This approach assumes that each sediment sample represented an exposure point within a particular EU (instead of calculating EU-wide RME and CTE EPCs for deriving the HQs presented above). The same general pattern is apparent from these data, namely: (a) the sediment quality at the mouths of mainstem Cement and Mineral Creeks is no worse, and in many cases substantially better, than in the reaches of the Animas River above and below these two creeks, (b) Pb, Mn and Zn are the major sediment risk drivers to the benthic invertebrate community in the Animas River, and (c) sediment risk is typically higher in the Animas River above mainstem Cement Creek compared to below mainstem Mineral Creek, indicating the presence of contaminant sources further upstream.

5.2.2 Measurement endpoint 1B

Compare the metal levels measured in pore water samples collected from substrate in the field to CSWBs.

The pore water risk characterization consists of calculating RME and CTE HQs for all the pore water COPECs identified across the various EUs. A complicating factor in these risk calculations is that the toxicity of many COPECs depends on hardness. Hence, the pore water RME and CTE EPCs for the hardness-sensitive metals presented in Section 4 need to be compared to chronic benchmarks adjusted for "reasonable minimum" and "average" pore water hardnesses (note: the toxicity of hardness-sensitive metals increases with decreasing hardness; hence, a reasonable minimum hardness was required as a conservative value for use in the pore water HQ calculations).

A reasonable minimum hardness was obtained as follows:

- The pore water hardness data were organized by EU (note: not enough pore water samples were available to calculate hardness by hydraulic period).
- For datasets too small to be evaluated using the ProUCL software, an average and a minimum pore water hardness was obtained from the available data to derive the pore water HQs for the hardness-sensitive metals.
- For the larger dataset (i.e., Animas River above mainstem Cement Creek), a 95% UCL and an average pore water hardness were calculated, after which the difference between the 95% UCL and the average was subtracted from the average to obtain a "reasonable

minimum" pore water hardness value. Both the average and reasonable minimum hardness values were then used to calculate chronic benchmarks and derive the pore water HQs for the hardness-sensitive metals.

Table 5.11 summarizes the procedure used to obtain the hardness values required to calculate the pore water RME HQ and CTE HQs for the hardness-sensitive metals. Note that the RME and CTE HQs for Al were derived using only the standardized chronic benchmark of 87 μg/L, even though CDPHE (2013) determined that the toxicity of Al in surface water was sensitive to hardness. The reason for using this simplifying step is that CDPHE (2013) also requires evaluating pH as an additional variable to determine if the hardness-sensitive equation or the standard benchmark of 87 μg/L should be used. pH was not measured in the pore water samples and was therefore not available.

5.2.2.1 Mainstem Mineral Creek

Table 5.12 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water from mainstem Mineral Creek.

Two COPECs were retained for further evaluation but neither one was present above its analytical DL in the one pore water sample collected from this EU. The RME and CTE HQs equaled 1.5 for Be and 1.9 for Ag.

These results were inconclusive because they were derived from non-detect data. However, the lack of risk from the other COPECs suggests that pore water was unlikely to be a risk factor in this EU. This conclusion is highly tentative because it is based on a single sample.

5.2.2.2 Animas River

Animas River above mainstem Cement Creek

Table 5.13 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water from the Animas River above mainstem Cement Creek. Eight of the nine COPECs had RME and CTE chronic HQs above one. Cd, Cu and Zn represented the three COPECs with the highest HQs.

The HQs for these three metals indicated the presence of severe risk to benthic invertebrates exposed to pore water at this EU. However, a review of the analytical data (see **Appendices 3.1 and 3.2**) showed that this risk was driven by unusually high concentrations measured at sampling location A61 in April 2014 ([Cd] = 100 μg/L; [Cu] = 2,250 μg/L; [Zn] = 29,900 μg/L) and in September 2014 ([Cd] = 106.5 μg/L; [Cu] = 95.9 μg/L; [Zn] = 18,490 μg/L). Lower, but

still substantial levels of these three metals were also measured at sampling location A65 during the same two 2014 pore water sampling events. It is unclear if these high levels represent potential hot spots. It was noteworthy that the metal levels in the pore water samples collected from sampling locations A60 (April and September 2014) and A64 (April 2014 only—a pore water sample was not collected from A64 in September 2014), appeared more normal. A60 is located upstream of A61, whereas A64 is located between A61 and A65.

The data suggests that pore water, at least in some locations of the Animas River above mainstem Cement Creek, presents high risk to the local benthic invertebrate community, but that this risk may be localized.

- **Animas River at sampling location A72 below mainstem Mineral Creek**

Table 5.14 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A72. Al, Be, Cd, Ag, and Zn had RME and CTE chronic HQs above one.

The three COPECs with the highest chronic HQs consisted of Zn (low hardness RME chronic HQ = 8.8), Al (RME chronic HQ = 5.9), and Cd (low hardness RME chronic HQ = 5.0).

The data suggested that pore water at sampling location A72 presented a high risk to the local benthic invertebrate community.

- **Animas River at sampling location A73 below mainstem Mineral Creek**

Table 5.15 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A73. Be, Cd, Ag, and Zn had RME and CTE chronic HQs above one.

The three COPECs with the highest chronic HQs consisted of Zn (low hardness RME chronic HQ = 4.0), Cd (low hardness RME chronic HQ = 3.5), and Ag (low hardness RME chronic HQ = 1.6).

The data suggests that pore water at sampling location A72 presents moderate risk to the local benthic invertebrate community.

- **Animas River at sampling location A73B below mainstem Mineral Creek**

Table 5.16 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A73B. Be and Ag had RME and CTE chronic HQs above one.

These two COPECs were retained for further evaluation but neither one was present above its analytical DL in the one pore water sample collected from this EU in September 2014. The RME and CTE chronic HQs equaled 1.5 and 11 for Be and Ag, respectively.

These results were inconclusive because they were derived from non-detect data. However, the lack of risk from the other COPECs suggested that pore water was unlikely to be an overriding risk factor in this EU. This conclusion was highly tentative because it was based on a single sample.

- **Animas River at sampling location A75D below mainstem Mineral Creek**

Table 5.17 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location A75D. Be, Cd, Ag, and Zn had RME and CTE chronic HQs above one.

The three COPECs with the highest chronic HQs consisted of Ag (low hardness RME chronic HQ = 3.6), Cd (low hardness RME chronic HQ = 1.9), and Zn (low hardness RME chronic HQ = 1.6).

Ag was not detected in either pore water samples collected in 2014. The Ag HQs were derived using one-half the highest DL and were therefore highly uncertain. The data suggested that pore water at sampling location A75D presented low risk to the local benthic invertebrate community.

- **Animas River at sampling location Bakers Bridge below mainstem Mineral Creek**

Table 5.18 presents the chronic HQs for benthic invertebrates exposed to COPECs in pore water collected from sampling location BB. Be, Fe, Mn, and Ag had RME and CTE chronic HQs above 1.0.

The three COPECs with the highest chronic HQs consisted of Mn (low hardness RME chronic HQ = 3.3), Ag (RME chronic HQ = 2.3), and Be (RME chronic HQ = 1.5).

Be and Ag were not detected in either pore water samples. Their HQs were derived using one-half the highest DL and were therefore highly uncertain. The data suggests that pore water at sampling location BB presents low risk to the local benthic invertebrate community.

Risk conclusion for measurement endpoint 1B

High pore water risk in bedded sediment was identified in the Animas River above mainstem Cement Creek. Much of that risk was associated with one sampling location (A61) that showed unusually high levels of contamination in the pore water samples collected in April and September 2014. The sample locations upstream (A61) and downstream (A64) from A61 appeared much less impacted, suggesting that the high contaminant levels at A61 may represent a pore water "hot spot".

Low to moderate pore water risk is associated with most of the sampling locations in the Animas River below mainstem Cement Creek.

5.2.3 Measurement endpoint 1C

Assess survival and growth of H. azteca exposed for ten days to field-collected sediment samples.

Section 3.6.2 summarizes the results of the two sediment toxicity tests performed in December 2012 and November 2014. All the field-collected samples resulted in a statistically significant response, either in terms of increased mortality (particularly in the December 2012 test) or reduced biomass (in both toxicity tests). The most toxic samples were associated with CC49 (mainstem Cement Creek; 0% survival), M34 (mainstem Mineral Creek; 8.8% survival) and sampling location A73B (5.0 %) survival). Except for sampling location A56, survival in the other locations tested both in December 2012 and November 2014 improved substantially (i.e., A68, A72, and BB), suggesting an improvement in sediment quality. However, that improvement was negated by the fact that biomass was still significantly affected. The survival in sediment from "upstream" location A56 equaled 62.5% in December 2012 and 43.8% in December 2014. This pattern indicates that sediment at this location was impacted by one or more sources further upgradient that were unrelated to inputs from mainstem Cement Creek or mainstem Mineral Creek.

Risk conclusion for measurement endpoint 1C

The two, ten-day *H. azteca* sediment toxicity tests identified severe effects, either on survival, growth, or both of these endpoints combined, in all of the sediment samples. The lowest survival was measured in the samples collected from M34, CC49, A72 and A73B. However, survival and biomass measured in all the other sampling locations were also significantly lower compared to the laboratory control sample. It was concluded that acute toxicity was present at all of the sediment sampling locations tested in December 2012 and November 2014 between A56 and BB.

5.2.4 Measurement endpoint 1D

Section 3.6.3 describes the results of the 2014 benthic community survey. In the fall of 2010, Mr. Chester Anderson (B.U.G.S. Consulting) prepared a benthic community data analysis report for the Animas River Stakeholder's Group (see **Appendix 16**). This report summarized the results of benthic surveys performed in the Animas River, Cement Creek, and Mineral Creek in 1992, 1996, 1997, 2004, 2006, 2007, 2009, and 2010. Some of the sampling locations in those previous surveys matched or overlapped with several locations surveyed by EPA in 2014, as follows:

- "Mineral Creek at mouth" corresponds roughly with sampling location M34.
- "Animas above Cement" correspond roughly with sampling location A68.
- "Cement Creek at mouth" corresponds roughly with CC49.
- "Animas @ A72" corresponds with sampling location A72.
- "Animas above Cascade" corresponds roughly with sampling location A75D.

Four of the benthic metrics presented in the 2010 Anderson report matched several of the 2014 metrics summarized in **Appendix 11** in this BERA (see also **Table 3.24**), as follows:

- # of taxa
- # of EPT taxa
- % EPT taxa
- Shannon diversity index (H')

The match between five sampling locations and four metrics afforded an opportunity to determine how the benthic community measured in 2014 compared to previous surveys. Note the following caveats: (a) it is unclear how well four of the five comparable sampling locations actually matched up, (b) the 2010 Anderson report provides no information on the sampling process to determine how well it reflected the 2014 effort, (c) the Anderson report does not state when the benthic invertebrates were collected to determine if the sampling periods corresponded to the September timeframe of the 2014 survey, and (d) many more metrics are available but were not evaluated. These uncertainties should be kept in mind when reviewing the data presented below.

For the sake of simplicity, it was decided to focus the historic data review specifically on Animas River locations A68, A72 and A75D, and to skip the two creek locations. **Appendix 16** identified sampling years 1992, 1996, and 1997 as "baseline". For the current analysis, the four common metrics of interest (i.e., # of taxa, # of EPT taxa, % EPT taxa, and H') obtained at each of the three Animas River locations were averaged across the three "baseline" years. Each of those average metrics was then assigned a relative value of 100. The same four metrics measured in 2004, 2006, 2007, 2009, 2010, and 2014 at the three target Animas River sampling locations

were then scaled relative to the "baseline" values of 100. This approach allowed for a standardized comparison of the four metrics across time and space, no matter their actual values. **Figure 5.3** presents the outcome of this analysis. The general patterns can be interpreted as follows:

- The number of benthic invertebrate taxa observed in 2014 increased at A72 and A75D compared to the previous survey performed in 2010, and remained roughly similar at A68. However, at none of the three Animas River sampling stations did the number of benthic invertebrate taxa in 2014 substantially exceed the baseline from the mid 1990's (see **Figure 5.3a**).

- The number of EPT taxa observed in 2014 decreased compared to 2010 at A68 and remained (roughly) the same at A72 and A75D. However, at none of the three Animas River sampling stations did the number of EPT taxa in 2014 exceed the baseline from the mid 1990's (see **Figure 5.3b**).

- The percent of EPT taxa observed in 2014 decreased at all three sampling stations compared to 2010. In addition, the percent of EPT taxa was substantially lower at all three locations compared to the baseline from the mid 1990's (see **Figure 5.3c**).

- The Shannon diversity index (H') observed in 2014 increased substantially at all three sampling stations on the Animas River compared to the previous survey performed in 2010. This metric in 2014 also exceeded the baseline from the mid 1990's at all three locations (see **Figure 5.3d**).

Risk conclusion for measurement endpoint 1D

In general, comparing select 2014 benthic community survey metrics with the same metrics from "historic" data suggested that the conditions for the benthic invertebrate community at sampling locations A68, A72 and A75D in the Animas River have not substantially improved since the mid-1990's. A72 appears to be the most impacted of the three sampling locations, particularly when compared to A68. The marked increase in the Shannon diversity index at all three locations in 2014 indicates that the benthic invertebrate community was more diverse than in previous sampling years, which is a positive development. However, it is unknown if this trend will be sustained in the future because it is based on data from only the last community survey in 2014.

Risk conclusion for assessment endpoint 1 (benthic invertebrate community)

Taken together, the four independent measurement endpoints (i.e., comparison of bulk sediment chemistry to sediment benchmarks, comparison of field-collected pore water chemistry to surface water benchmarks, sediment toxicity tests, and recent plus past benthic community survey results) show a strong potential for risk to the benthic invertebrate community in the Animas River between sampling location A56 and BB, as well as in mainstem Cement and Mineral creeks.

The sediment HQ evaluation and sediment toxicity test results did not provide a consistent picture. The sediment HQ analysis identified sediment samples CC49 and M34 as the least impacted by metals, whereas sediment samples A75B, BB, and the Animas River upstream of Cement Creek were the most impacted by metals. This pattern is contrary to the outcome of the sediment toxicity test, which showed the highest toxicity at CC49 and M34 and lower (relative) toxicity in the Animas River above mainstem Cement Creek, plus A75B and BB.

Appendices 17.a and 17.b compare the *H. azteca* mortality and biomass responses from the two sediment toxicity tests (summarized in **Table 3.23**) against the HQs of key "risk driving" metals measured in pore water and corresponding sediment samples collected from each of the toxicity test vessels in December 2012 and November 2014. The data analysis proceeded as follows:

- The evaluation focused on metals that yielded the highest HQs. Those metals were Al, As, Cd, Cu, Pb, Mn, and Zn.
- The sediment toxicity tests pore water HQs for the non-hardness dependent metals were obtained by dividing the detected concentrations (or half the DL for non-detect metals) of the dissolved metals measured in pore water by their corresponding CSWBs presented in **Table 3.1**
- The sediment toxicity tests pore water HQ for the hardness-dependent metals were obtained using the equations presented in **Table 3.1** to first calculate CSWBs based on the sample's hardness value and then dividing the dissolved concentrations of the hardness-dependent metals measured in pore water by these sample-specific surface water benchmarks (note: Al HQs were calculated using the standard benchmark of 87 µg/L).
- The sediment toxicity tests sediment HQs were calculated by dividing the detected concentrations (or half the DL for non-detect metals) by their corresponding effect sediment benchmarks presented in **Table 3.1**.

The results, which did not provide a consistent pattern, can be interpreted as follows:

December 2012 test (Appendix 17.a)

- The highest risk potential to *H. azteca* was associated with exposure to Pb, Mn and Zn in the bulk sediment, followed by As, Cd, and Cu.
- Toxicity to *H. azteca* from exposure to pore water in the test sediment appeared to be sporadic across the sampling locations, except for Mn.
- Only for sampling location CC49 can it be stated with some level of confidence that pore water may have been a likely cause of the observed toxicity to *H. azteca*.
- The high toxicity at sampling location M34 was puzzling giving the relative absence of pore water or bulk sediment risk (e.g. compare the response and chemistry of M34 to A68). This observation suggests the presence of an unaccounted factor resulting in high toxicity to benthic invertebrates in mainstem Mineral Creek

November 2014 test (Appendix 17.b)

- The highest risk potential to *H. azteca* was associated with exposure to Pb, Mn and Zn in the bulk sediment, followed by Cd and Cu.
- Toxicity from exposure to pore water in the test sediment was most pronounced for Cd, followed by Mn and Zn. However, the highest Cd risk associated with power water exposure occurred at the sample collected from location A60, even though *H. azteca* survival and biomass in that sample were no worse than at other locations.
- With some exceptions, the initial and final pore water HQs were remarkably similar. This pattern suggested that equilibrium between the pore water and bulk sediment was established within 24 hours of adding the sediment samples to the test beakers, and that the daily surface water renewal in the test beakers over the ten-day test did not affect the composition of the pore water.

The chemistry versus toxicity evidence, although contradictory, was weighed in favor of the sediment toxicity test because it measured direct effects on a sensitive benthic invertebrate species exposed for ten days to field-collected sediment samples. Additionally, the two sediment toxicity tests met the test acceptability criteria for both survival and growth, and were therefore more precisely valid for use in this report. The exact cause of toxicity to *H. azteca* (and by extension the benthic invertebrate community) is unclear, but the effects on survival and growth are uncontroversial.

5.3 Community-level aquatic receptors – fish

The risk characterization for fish was based on two separate but complimentary approaches.

The first approach is identical as described in Section 5.2.2 to derive "reasonable minimums" and average hardness values for use in calculating hardness-specific CSWBs. **Table 5.19** presents the surface water hardness values for each EU and hydraulic period.

The second approach used in the surface water risk characterization consisted of assessing the concentrations of key surface water COPECs (i.e., pH, Al, Cd, Cu, Mn, Pb, and Zn) on a sample-by-sample basis to create scatter plots. These plots are provided in **Figure 5.4.a-c** (pH), **Figure 5.5.a-c** (total Al), **Figure 5.6.a-c** (dissolved Cd), **Figure 5.7.a-c** (dissolved Cu), **Figure 5.8.a-c** (dissolved Mn), **Figure 5.9.a-c** (dissolved Pb), and **Figure 5.10.a-c** (dissolved Zn).

Assessment endpoint 2: Maintain a stable and healthy fish community. *Are the metal levels in surface water from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek, between mainstem Cement Creek and mainstem Mineral Creek, and below mainstem Mineral Creek high enough to impair the fish in these waterways?*

The potential for ecological risk to the fish community in the three waterways was assessed as follows.

5.3.1 Measurement endpoint 2A

Compare metal levels measured in surface water samples to CSWBs.

5.3.1.1 Mainstem Mineral Creek

Table 5.20 presents the surface water HQs for the fish community in mainstem Mineral Creek. All surface water samples were collected at one location (M34) by the mouth of the creek.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data showed that surface water pH can drop as low as around five during the pre-runoff period, but then stays mostly at or above six during the runoff and post-runoff period.

- **Metals**

The RME and CTE HQs for Al, Cd, Fe, Ag, and Zn had HQs that exceeded one during all three hydraulic periods. The highest risk in this EU is associated with severe Al exceedances. The other exceedances were relatively minor in comparison. The risk from Ag is highly uncertain because it was based mostly on half of the analytical DLs, as opposed to actual detected concentrations.

It is concluded that surface water pHs of around five combined with high Al levels during the pre-runoff period can be potentially lethal to aquatic receptors depending on the duration of the low pH or high Al event. At a minimum, such conditions are expected to cause severe stress to fish during the pre-runoff period.

5.3.1.2 Mainstem Cement Creek

Table 5.21 presents the surface water HQs for aquatic, community-level receptors in mainstem Cement Creek. All surface water samples (except for one obtained at CC49) were collected from CC48, located close to the confluence with the Animas River.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data showed that pH remained entirely below six during all sampling events between 2009 and 2014, with pH excursions well below four during both the pre and post-runoff seasons. Irrespective of the surface water metals concentrations presented below, these pH levels can be expected to be acutely lethal to all fish.

- **Metals**

The RME and CTE HQs for Al, Be, Cd, Cu, Fe, Mn, Pb, and Zn exceeded one during all three hydraulic periods. The highest risk in this EU is associated with severe Al exceedances. The other exceedances were relatively minor in comparison, but were still expected to be lethal, particularly for Cd, Cu, and Zn.

It is concluded that the chemical conditions in the surface water from mainstem Cement Creek cannot support a viable fish community.

5.3.1.3 Animas River

Animas River above mainstem Cement Creek

Table 5.22 presents the surface water HQs for the fish community in the Animas River above mainstem Cement Creek.

- **pH**

Figure 5.4.a provides the scatter plots for pH in this EU. The data showed that pH remained above six during all sampling events between 2009 and 2014. Hence, pH was not considered to be a stressor in this reach of the Animas River.

- **Metals**

Al, Cd, Cu, Mn, and Zn had HQs above one during one or more of the hydraulic periods, although the exceedances were in general relatively minor. **Figures 5.5.a** (Al), **5.6.a** (Cd), and **5.10.a** (Zn) suggested the presence of a source of these metals upstream of this EU. The lack of a robust surface water dataset from sampling location A56 ("upstream") precludes determining if the Mayflower Mill, situated just above the confluence of Arrastra Creek with the Animas River between sampling locations A56 and A64, may be a potential source for these three metals, or if the source is located further upstream in the watershed.

Therefore, this BERA concludes the chemical conditions in the surface water from the Animas River upstream of mainstem Cement Creek between sampling locations A60 and A68 may result in chronic toxicity to the fish community, mainly due to Al, Cd, and Zn. Additionally, this potential risk is unrelated to contamination from mainstem Cement Creek.

Animas River between mainstem Cement Creek and mainstem Mineral Creek

Table 5.23 presents the surface water HQs for the fish community in this short reach of the Animas River. Only two surface water samples were collected from the two sampling locations in October of 2012 (post-runoff period).

- **pH**

Figure 5.4.b provides the scatter plots for pH in this EU. The two data points showed that the pH levels during the post-runoff period were at or below the minimum threshold of six. Hence, pH was considered to be a potential minor stressor in this reach of the Animas River. This acidity reflected input of low-pH surface water from mainstem Cement Creek located at the upstream

end of the reach (see **Figure 1.1**). This conclusion is supported by the fact that pH in the Animas River above mainstem Cement Creek was invariably well above six.

- **Metals**

Al, Cd, Cu, Fe, Mn, and Zn had HQs that exceeded one during the post-runoff period, although the exceedances were in general relatively minor, except for Al. The limited contaminant profile suggested that the surface water chemistry in this reach of the Animas River could cause severe chronic toxicity to fish from a combination of low pH and high Al levels, together with the presence of several other metals at lower concentrations.

Animas River below mainstem Mineral Creek

Tables 5.24 to 5.30 present the surface water HQs for aquatic, community-level receptors in the seven EUs of the Animas River below mainstem Mineral Creek. Those EUs were combined for the purpose of this discussion because their risk patterns were quite similar.

- **pH**

Figures 5.4.b and c provide the scatter plots for pH in this reach of the Animas River. Sampling location A72 showed that pH dropped down to around five during the pre-runoff period. Surface water samples were collected from sampling locations A73, A75D, and BB in April 2014, but pH was not measured in any of these samples. None of the other EUs in this reach were sampled for surface water during the pre-runoff season. Hence, it is unknown how much further the low pH profile extends downstream prior to snowmelt. This acid pulse most likely originates from both mainstem Cement Creek and mainstem Mineral Creek (see **Figure 5.4.a**), instead of from further upstream on the Animas River. The sparse dataset for the EUs downstream from A72 suggested that pH was not an issue during the runoff and post-runoff periods.

- **Metals**

Al, Cd, Cu, Fe, Mn, and Zn exceeded a pH of one during one or more of the hydraulic periods, although the exceedances were in general relatively minor, except for Al. The limited contaminant profile suggested that the surface water chemistry in this reach of the Animas River could cause severe chronic toxicity to fish during the pre-runoff period from a combination of low pH and high Al levels. The presence of several other metals at lower concentrations might further exacerbate this trend.

Risk conclusion for measurement endpoint 2.A

The prevailing conditions in mainstem Cement Creek were expected to be acutely lethal to fish, mainly as a result of low pH and high Al levels, coupled with excessive amounts of Cd, Pb, and Zn.

The prevailing conditions in mainstem Mineral Creek appear to be less extreme but should still result in severe stress to fish, mainly due to low pH in the pre-runoff period and high Al levels throughout the year.

The prevailing conditions in the Animas River above mainstem Cement Creek reflected one or more sources of Al, Cd and Zn contamination upstream of this reach, although low pH was not an issue. It appears likely that the prevailing conditions should result in chronic stress to the local fish community in this reach of the river.

The prevailing conditions in the Animas River between mainstem Cement Creek and mainstem Mineral Creek can only be assessed based on two surface water samples. This limited dataset suggested that the conditions in this reach of the Animas River reflected input from mainstem Cement Creek and from the Animas River upstream of Cement Creek. Low pH and high Al were expected to be risk drivers to the local fish community, as well as Cd and Zn.

The prevailing conditions in the Animas River below Mineral Creek were difficult to assess properly because only sampling location A72, situated about one mile downstream of the confluence with mainstem Mineral Creek was sampled over a five-year period. The limited data suggested that Al, Cd, and Zn would likely result in chronic stress to the local fish community, even though a possible trend showed lower HQs further downstream. However, this trend could not be confirmed due to the few available data points.

To provide a partial remedy for this data gap, EPA installed "MiniSipper" sampling devices at several locations in the Animas River below mainstem Mineral Creek, specifically A73, A75D, and BB (note: MiniSippers were also installed at locations A56, A66 and A68 in the Animas River above mainstem Cement Creek; however, the devices at locations A66 and A68 were lost during the 2014 spring runoff event). These sampling devices were deployed in mid-April before the spring runoff and retrieved in mid-July after the runoff concluded. On a daily basis, each device collected and stored a five milliliter integrated surface water sample within a sample coil. Each sample was preserved with 0.25 milliliter nitric acid (stabilizing reagent) to a pH of less than or equal to two and filtered in-situ through a ten micron, ultra-high molecular-weight polyethylene solvent filter. The filtered samples were separated from one another inside the sample coil by a small injected nitrogen gas bubble. The sample coils were returned to the

laboratory at the end of the three-month sampling period for analysis of the water samples for dissolved metals and hardness.

The interpretation of the MiniSipper analytical data focused on Al, Cd, Cu, Pb, and Zn, all of which have aquatic toxicities that depend on hardness (CDPHE, 2013). For the latter four metals, the daily hardness concentrations were used to derive "daily" hardness-adjusted benchmarks. The metal concentrations measured that day were divided by their hardness-adjusted benchmarks to generate "daily" HQs. This approach was also used for Al, except that the Al data set did not include total Al concentrations and pH, both of which are required to derive Al benchmarks per the CDPHE (2013) guidance. Instead, the Al HQs were calculated by dividing the daily dissolved Al concentration by the standard benchmark of 87 µg/L provided by CDPHE (2013). The HQs were then plotted for the five metals over time and across the four sampling locations (i.e., A56, A73, A75D, and BB) to help visualize changes in risk to fish at select locations in the Animas River from mid-April 2014 until mid-July 2014.

Note that the MiniSipper data had important limitations, including the potential for "smearing" between adjacent samples in the sample coils, limited QA capabilities, and the need for using a 10 µm versus a 0.4 µm filter to generate the dissolved samples. As a result, the data were only used semi-quantitatively to provide the supporting evidence presented below.

Figure 5.11 summarizes the plots associated with this analysis, which can be interpreted as follows:

- Aluminum:

The Al HQs started increasing towards the middle of May 2014 and exceeded unity (HQ of one) at the end of that month, except for sampling location A73. These HQ exceedances remained below five and were largely gone by the second half of June 2014. Sampling location A56 showed the highest risk from Al.

- Cadmium

The Cd HQs consistently exceeded one but stayed largely below five during the 2014 pre-runoff period at sampling locations A56, A73, and A75D. These HQ exceedances persisted throughout the runoff period, during which time the Cd HQs at BB were also slightly above one. The excess risk from Cd was largely removed by mid-June 2014.

- Copper

Copper was not a risk issue at any of the three MiniSipper sampling locations on the Animas River below mainstem Mineral Creek between April and July 2014. The HQs exceeded one but stayed below five at sampling location A56 during the 2014 runoff period.

- Lead

The Pb HQs started increasing towards the middle of May 2014 and were above one at the end of that month, except for sampling location A73. These HQ exceedances stayed below five, except for sampling location A56, and were largely gone by the second half of June 2014. Sampling location A56 showed the highest risk from Pb.

- Zinc

The pattern for the Zn HQs was similar to that observed for Cd, namely the HQs consistently exceeded one but stayed largely below five during the 2014 pre-runoff period at sampling locations A56, A73, and A75D. These HQ exceedances persisted throughout the runoff period, during which time the Cd HQs at BB were also slightly above one. The excess risk from Cd was largely gone by mid-June 2014.

The 2014 MiniSipper data mostly reflected the general trends summarized in **Figures 5.5 to 5.10**, namely: (a) the risk to fish increased during the runoff period and then subsided later on in the summer, (b) risk from Cd and Zn was consistently present during the pre-runoff period (except for the BB sampling location), and (c) a persistent risk signal was associated with the samples collected at sampling location A56, located upstream of A60 on the Animas River above mainstem Cement Creek. Multi-week exceedances of chronic HQs at the various sampling locations on the Animas River can be expected to have long-term detrimental effects on the local fish populations.

As a final note, the Al HQs summarized in Figure **5.11a** were lower than those provided in **Figure 5.5** for the same sampling locations. The reason is partly because the benchmark calculation methods differed since the MiniSipper Al data represented dissolved Al and lacked the pH data needed to select the proper HQ calculation method.

5.3.2 Measurement endpoint 2B

Assess survival in juvenile rainbow trout (Oncorhynchus mykiss) exposed for 96 hours in the laboratory to surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above mainstem Cement Creek and below mainstem Mineral Creek.

Section 3.6.1 summarizes the results of the acute toxicity tests using juvenile rainbow trout. **Table 3.22** provided the survival data. The toxicity tests were performed using surface water collected during the pre-runoff period (April 2013) and the post-runoff period (October and November, 2012). No surface water samples were collected during the runoff period for use in toxicity testing.

Surface water samples collected from mainstem Cement Creek, mainstem Mineral Creek, and sampling location A72 on the Animas River below mainstem Mineral Creek were acutely toxic to juvenile rainbow trout. Sampling location A68 in the Animas River above mainstem Cement Creek was acutely toxic in April 2013 but not in the fall of 2012, strongly suggesting the presence of a seasonal chemical stressor in this reach of the river that is not associated with input from mainstem Cement or Mineral Creeks.

No significant acute toxicity was observed for juvenile rainbow trout exposed to surface water collected from the EUs below sampling location A72. This pattern suggested that the acute toxicity measured in A72 was "diluted out" by the time the river reached sampling location A73, about six miles downstream of the confluence with mainstem Mineral Creek.

5.3.3 Risk Conclusions for assessment endpoint 2 (fish community)

- **Mainstem Cement Creek:**

The chemical conditions in surface water from mainstem Cement Creek were highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests showed that surface water collected from this EU in November (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout (see **Table 3.22**). The preponderance of the evidence suggested that the fish community in mainstem Cement Creek (if present) would experience high stress under current conditions.

- **Mainstem Mineral Creek:**

The chemical conditions in mainstem Mineral Creek appeared less severe than in mainstem Cement Creek for the local fish community. However, severe pH drops and high Al levels during

the pre-runoff period suggested that fish may experience high stress in the winter, but that survivors could possibly recover during the remainder of the year. The toxicity tests showed surface water collected from this EU in November (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout (see **Table 3.22**). The preponderance of evidence suggested that the fish community in mainstem Mineral Creek (if present) would likely experience severe acute stress under current conditions.

- **Animas River above mainstem Cement Creek:**

The chemical conditions in the Animas River above mainstem Cement Creek suggest the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggests that chronic toxicity to the fish community is possible, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, is not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout exposed to surface water from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggested that the fish community in this reach of the Animas River may experience acute or chronic stress during much of the year.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

The amount of chemical information on the quality of the surface water is limited because only two samples were collected and no acute toxicity testing was performed. The limited amount of data suggested that this reach of the Animas River was likely to be lethal to fish, mostly due to low pH and high levels of aluminum, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflected the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre and post-runoff periods were acutely toxic to juvenile rainbow trout. The surface water samples collected during the same two hydraulic periods from the EUs further downstream did not show acute toxicity, suggesting that the acute effects had been "diluted out". However, the preponderance of evidence (including the semi-quantitative MiniSipper datasets summarized in **Figure 5.11**) shows that Al, Cd, and Zn in surface water may exert chronic stress to the fish community all the way to the BB EU located about 30 miles downstream from Silverton.

This general conclusion was strongly supported by the results of a fisheries survey performed by the Colorado Division of Wildlife (CDOW, 2010; see **Appendix 18**). The CDOW electroshocked the Animas River below mainstem Mineral Creek at locations "A-72 USGS"

(equivalent to sampling location A72), "Elk Park" (in the vicinity of sampling location A73), and "Teft Spur" (in the vicinity of sampling locations A75D/A75B). The CDOW also sampled the Animas River above mainstem Cement Creek but at a location well upstream of A60, and therefore outside of the current area of concern.

The data consisted of fish counts ("fish per mile" organized by trout species) sampled at these three locations in 1992, 1998, 2005, and 2010 (see Table 5 on p. 15 in **Appendix 18**). The data show that between 1992 and 2005, trout were essentially absent from A72, present at a low but steady level at Elk Park (vicinity of A73), and present at a much higher and steady level at Teft Spur (vicinity of A75D/A75B). The trout populations crashed at all three locations between 2005 and 2010, both in abundance and distribution. CDOW (2010) suggested that the main cause for this sudden collapse was associated with the discontinuation of a large water treatment project in the Gladstone area on Cement Creek upgradient from Silverton.

CDOW returned to Teft Spur (vicinity of A75D/A75B) on the Animas River below mainstem Cement Creek in September of 2014 for an additional electroshocking survey (see p. 29 to 32 in **Appendix 19**). The data showed that the reduced trout population observed in 2010 at this location was essentially eliminated by 2014.

In conclusion, the available evidence shows that the current conditions in the Animas River have had harmful effects on the local trout populations.

5.4 Aquatic invertivorous birds

The risk evaluation for the wildlife receptors generated numerous HQ tables. No effect and effect HQs were developed for both RME and CTE exposure scenario, resulting in four HQs for ten analytes across seven EUs on the Animas River. Four of the ten "important bioaccumulative compounds" assessed for risk via food chain modeling showed a potential for wildlife risk. Those compounds consisted of Cu, Pb, Se, and Zn.

The data presentation and interpretation outlined below for aquatic invertivorous birds (and the three other wildlife receptor species) was simplified by focusing the discussion only on those four compounds and calculating a geometric mean of the no effect and effect HQs for both the RME and CTE exposure scenario. A geometric mean was obtained by (a) taking the natural log of a no effect HQ and its corresponding effect HQ, (b) adding the two logged values, (c) dividing the sum by 2, and (d) taking the anti-log of the result. Those RME and CTE "geomean HQs" were then plotted for each wildlife receptor to help visualize the potential for ecological risk across all the Animas River EUs.

Assessment endpoint 3: Maintain stable and healthy invertivorous bird populations. *Are the metal levels in surface water, sediment, and benthic invertebrates high enough to impair invertivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.4.1 Measurement endpoint 3A

Use metal concentrations measured in sediment and benthic invertebrates in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and benthic invertebrates, and compare these EDDs to avian TRVs.

Tables 5.31 to 5.37 provide the HQs for this receptor across all of the wildlife EUs. **Figure 5.12.a** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings was considered low because it was based on a single, semi-qualitative Line of Evidence (LOE).

This measure of effect identified Cu as a risk driver to invertivorous birds ingesting surface water, sediment, and aquatic invertebrates from the Animas Rive at sampling locations A73B and A75B. The highest risk for Cu (RME geometric mean HQ = 5.6 and CTE geometric mean HQ = 2.6) was identified at A75B. Minor risk was also found for Zn (RME geometric mean HQ = 1.6 and CTE geometric mean HQ = 1.1) in the Animas River above mainstem Cement Creek, and for Se at sampling location A73B (RME geometric mean HQ = 1.2 and CTE geometric mean HQ = 1.2).

The southwestern willow flycatcher, which is listed as an endangered bird species both at the federal and state level, might forage for aquatic insects and breed in the riparian habitats along the Animas River downstream of Silverton. It is not known if this bird is actually present on the Animas River, but this BERA assumes it to be the case as a precautionary measure. It was decided that the no effect HQ under a RME scenario would provide a conservative assessment of risk for this protected species. Under that scenario, a potential for risk, primarily from Cu, but also from Se and Zn were identified both in the Animas River reach above mainstem Cement Creek and at sampling locations A73B and A75B in the Animas River below mainstem Cement Creek.

No benthic invertebrates were collected for tissue residue analysis from sampling locations A73B and A75B. Hence, the levels of metals in benthic tissues used in calculating EDDs were estimated using conservative published sediment-to-benthic invertebrate regression models and

uptake factors. It was noteworthy that the only two sampling locations with excessive risk from Cu were A73B and A75B (see **Figure 5.12a**). Given this pattern, it was concluded that the risk from Cu was hypothetical and unlikely to be realized in the field.

5.5 Aquatic omnivorous birds

Assessment endpoint 4: Maintain stable and healthy omnivorous bird populations. *Are the metal levels in surface water, sediment, benthic invertebrates, and aquatic plants high enough to impair omnivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.5.1 Measurement endpoint 4A

Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use the estimated plant residues and the measured benthic invertebrate residues in a food chain model to calculate metal-specific EDDs from ingesting surface water, sediment, and food, and compare these EDDs to avian TRVs.

The risk to aquatic omnivorous birds, represented by the mallard, was assessed based on the "100% diet" to model females feeding exclusively on benthic invertebrates prior to laying their eggs in the spring and on the "50%-50% diet" to model both males and females feeding on a mix of plants and benthic invertebrates for the remainder of the year.

Tables 5.38 to 5.44 provide the HQs for the 100% diet, and **Tables 5.45 to 5.51** provide the HQs for the 50%-50% diet. **Figures 5.12.d and 5.12.e** summarize the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn in the 100% diet and the 50%-50% diet, respectively. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings was considered low because it was based on a single, semi-qualitative LOE.

- 100% benthic invertebrate diet

Of the four major COPECs, only Cu was a minor risk concern to the mallard feeding on a 100% benthic invertebrate diet at sampling locations A73B and A75B in the Animas River below mainstem Mineral Creek. Pb, Se, and Zn were not a risk concern under this exposure scenario. As explained in the previous subsection, the small risk associated with Cu is considered hypothetical because it was derived based on estimated (instead of measured) benthic invertebrate tissue residue levels.

- 50% benthic invertebrate and 50% aquatic plant diet

None of the four major COPECs were a risk concern to the mallard feeding on a 50%-50% diet in the Animas above mainstem Cement Creek or below Mineral Creek. This finding suggested that mallards feeding on a 50%-50% diet are unlikely to be affected by the current conditions in the Animas River at the EUs evaluated in this BERA.

5.6 Piscivorous birds

Assessment endpoint 5: Maintain stable and healthy piscivorous bird populations. *Are the metal levels in surface water, sediment and fish high enough to impair piscivorous birds foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?*

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.6.1 Measurement endpoint 5A

Use metal concentrations measured in sediment samples to estimate metal residues in fish; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment and fish, and compare these EDDs to avian TRVs.

Tables 5.52 to 5.58 provide the HQs for this receptor. **Figure 5.12b** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings was considered low because it was based on a single, semi-qualitative LOE.

This measure of effect identified Pb as a minor risk driver to piscivorous birds ingesting surface water and fish from the Animas River. Risk from Pb exceeded unity (RME geometric mean HQ = 1.2 and CTE geometric mean HQ = 1.1) only in the reach of the Animas River above mainstem Cement Creek. Risk from Zn in the Animas River at the BB EU further downstream equaled unity but only for the RME geometric mean HQs; the CTE geometric mean HQs for Zn all fell below one.

5.7 Aquatic herbivorous mammals

Assessment endpoint 6: Maintain stable and healthy herbivorous mammal populations. *Are the metal levels in surface water, sediment, and aquatic plants high enough to impair*

herbivorous mammals foraging in the Animas River above mainstem Cement Creek and below mainstem Mineral Creek?

The potential for ecological risk to this receptor group was assessed using one measurement endpoint, as follows:

5.7.1 Measurement endpoint 6A

Use metal concentrations measured in sediment samples to estimate metal residues in aquatic plants; use food chain modeling to calculate metal-specific EDDs from ingesting surface water, sediment, and aquatic plants, and compare these EDDs to mammalian TRVs.

Tables 5.59 to 5.65 provide the HQs for this receptor. **Figure 5.11.c** summarizes the geometric mean RME and CTE HQs for Cu, Pb, Se, and Zn. The potential risks associated with the four major COPECs are discussed below. The reliability of the findings was considered low because it was based on a single, semi-qualitative LOE.

None of the four major COPECs were a risk concern to the muskrat consuming a 100% aquatic plant diet from the Animas above mainstem Cement Creek or below Mineral Creek. This finding suggested that muskrats are unlikely to be affected by the current conditions in the Animas River at the EUs evaluated in this BERA.

5.8 General risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

Minimal potential risk to wildlife receptors was observed in this reach of the Animas River associated with Zn (American dipper, as a surrogate for the federally and state-listed southwestern willow flycatcher) and Pb (belted kingfisher). It appears unlikely that this potential for risk is actionable because the geomean HQs barely exceeded unity.

- **Animas River below mainstem Mineral Creek**

Cu was identified as a potential risk driver to the American dipper and the mallard at sampling locations A73B and A75B. This risk was driven by estimated benthic tissue levels because no benthic invertebrates were collected from these two sampling locations for residue analysis. The other three major COPECs were not of concern to any of the wildlife receptor groups in this reach of the Animas River.

The increased risk of Cu in the American dipper versus the mallard was driven almost entirely by the higher food ingestion rate of the former species compared to the latter (0.0519 kg/kg/BW-day, dw, versus 0.2173 kg/kg BW-day, dw which results in a ratio of 4.2). This difference was because the average adult American dipper weighs 0.0565 kg and the average adult mallard weighs 1.162 kg (see **Table 4.29**). As such, the American dipper appears to be a suitably sensitive wildlife receptor for future risk evaluations on this river system.

5.9 Uncertainty Analysis

Uncertainty is inherent in any ecological risk assessment due to incomplete or inadequate knowledge about a number of key input parameters. This lack of knowledge is usually addressed by making exposure and toxicity estimates using the limited available data, or by making conservative assumptions based on guidance and best professional judgment when no reliable data are available. The major uncertainties associated with this BERA are discussed below.

5.9.1 Community-level receptors

- It is unclear if mainstem Cement Creek or Mineral Creek upstream of the confluence with South Fork Mineral Creek supported aquatic life before mining activities started in their watersheds in the 19th century (Church *et al*., 2007). If this observation is correct, then any impairment may not reflect negatively on current conditions in those two waterways. This situation represents a serious uncertainty, which would have to be considered as part of any future risk management decision-making.

- Except for Al and Fe, the surface water exposures evaluated in this BERA were based on dissolved metal concentrations, which represent the toxicologically "active" fraction of the total metals. Basing the surface water exposures on this fraction was not overly conservative and did not generate much uncertainty.

- Twenty sediment samples were collected from the reach of the Animas River above mainstem Cement Creek between A60 and A68. The data from these samples were pooled into a single, large dataset representative of that EU. The sediment datasets collected from the EUs on the Animas River below mainstem Mineral Creek were uniformly small (n = 3 to 5) which was not always enough to calculate representative EPCs using ProUCL. Hence, some uncertainty was associated with the risk conclusions derived from these smaller sediment datasets.

- Risk to community-level receptors was assessed using the HQ method. The HQs were not summed to calculate a Hazard Index (HI), because a HI assumes that HQs are additive. It is not anticipated that all of the inorganic COPECs evaluated in this BERA would exert

their toxic effects on one and the same organ, which is a basic requirement for calculating HIs. On the other hand, it is possible that some of the COPECs may in fact exert additive toxicity, in which case the HQ approach would underestimate certain risks. This observation applied equally to the wildlife evaluation.

- Be and Ag in surface water were retained as COPECs for community-level aquatic receptors even though these two analytes were not present above their DL in most of the EUs. The HQs represented half of the highest DL divided by the chronic benchmark. The HQ exceedances were particularly striking for Ag (see **Tables 3.5, 3.6, and 3.8**). It is not known if Be and Ag represent a realistic but unquantifiable concern for this BERA. This lack of information represents an uncertainty, which may need to be addressed as part of the risk management process.

- Only one benthic species (the amphipod *H. azteca*) was used for the sediment toxicity tests. Even though this species is considered sensitive to contamination, it is not known how much more or less sensitive it is compared to the benthic invertebrate species typically found in the Animas River upstream and downstream of Silverton. At a minimum, the fact that the toxicity endpoints responded significantly at all sampling locations in the ten-day sediment toxicity test compared to the laboratory sediment control sample showed that the test organisms were sensitive to the chemical conditions found in the field-collected sediment samples. As a result, the uncertainty about species sensitivity is small.

- Juvenile rainbow trout were used in the surface water toxicity tests. This species was directly relevant to the fish populations found in the Animas River. Rainbow trout (and particularly juvenile life stages) are considered quite sensitive to the presence of metals in surface water. Hence, the uncertainty associated with their response to the acute exposures in the laboratory was minimal. However, the test did not assess toxicity from chronic exposures typically experienced by fish populations in the Animas River. The lack of an acute response in juvenile rainbow trout at sampling locations A73, A73B, A75B, and BB did not imply that a toxic response would not be present under longer-term exposures in the laboratory. This data gap would have represented a large uncertainty by itself, but was negated by the results of the 2010 and 2014 fisheries surveys performed by the CDOW that showed sharp declines or complete extirpation of trout populations in the Animas River below mainstem Mineral Creek. These findings were further supported by the MiniSipper data that showed the presence of multi-week chronic toxicity for several metals in surface water before and during the snowmelt period. As a result of these two supporting lines of evidence, the uncertainty associated with the lack of acute toxicity to juvenile rainbow trout exposed to surface water samples collected from the lower reaches of the Animas River was minimal.

- All trout species bury their eggs in gravelly substrate during spawning. These eggs remain in the gravel for several months until they hatch. The sac fry stay in the substrate for several more weeks until they have resorbed their yolk sac, after which the juveniles emerge into the overlying surface water. Hence, for six plus months the embryo-larval stages of trout are fully exposed to metals in pore water (note: the surface water benchmarks are derived from toxicity tests on hatched fish, not eggs). This BERA used the pore water HQs for the Animas River presented in Table 5.13 to Table 5.18 only to assess the risk to the benthic invertebrate community. Those same data could also have been applied to the sac fry, which would show unacceptable risk from pore water exposure at all locations sampled for pore water in the Animas River. This particular assessment was not performed, however, because the other three lines of evidence already showed unacceptable risk to the fish community.

5.9.2 Wildlife receptors

- The exposure modeling used published Biota-to-Sediment Accumulation Factors (BSAFs) or regression equations, instead of field-collected tissue samples to estimate COPEC levels in fish and plants (and benthic invertebrates, but only at sampling location A73B and A75B from which tissue samples were not available). The evidence presented in this report strongly suggested that the literature-derived values for benthic invertebrates poorly predicted Site-specific contaminant uptake and tissue levels, resulting in uncertainty. As a result, the risk from Cu to the American dipper and mallard at sampling locations A73B and A75B was considered hypothetical. Additionally, the soil-to-plant regression models and uptake factors were derived from terrestrial studies because no studies have been published to measure sediment-to-plant contaminant uptake. It is not known if or how metal uptake in plants differs between soil and sediment, resulting in uncertainty about actual risk to the omnivorous birds and the herbivorous mammals feeding on aquatic plants.

- Benthic invertebrates were collected for residue analysis in September 2014. These samples provided measured (versus estimated) tissue data for use in the food chain models for the American dipper and the mallard. It is not known how much or if metal levels fluctuate in benthic tissue throughout the year or across years in the Animas River. Also, with only a single sample to work from, the RME and CTE concentrations derived from the benthic invertebrate samples for use in the EDD calculations were identical to each other. The small benthic invertebrate tissue residue dataset represents an uncertainty but it appears unlikely that additional benthic residue sampling events in the future would greatly change the current wildlife risks.

- The exposure modeling assumed that the Animas River reach above mainstem Cement Creek between sampling location A60 and A68 equaled a wildlife receptor's entire home range and forage range (i.e., area use factor = 1.0). This assumption was not unrealistic, given that this reach covered about two miles of river habitat, and therefore has limited uncertainty.

- Fourty surface water samples were collected from the reach of the Animas River above mainstem Cement Creek. Twenty five of those samples were collected at sampling location A68. But even though this data set was assumed to represent the entire EU, it focused on one specific location. The impact on the risk conclusions, however, is expected to be minimal. A review of the surface water chemistry data obtained from the six sampling location in this EU shows that the metal concentrations are quite similar to each other. As such, it appears unlikely that the current surface water dataset for the Animas River above mainstem Cement Creek generated unrepresentative EPCs.

- The exposure modeling included sediment ingestion. The substrate composition of the Animas River at and below Silverton appears to include large fractions of coarse sand, gravel, pebble, and small cobble, instead of the fine sands and silts expected to be accidentally ingested by wildlife receptors during feeding. The actual incidental sediment ingestion may be substantially lower than assumed in the food chain models, which would slightly decrease the calculated risks.

- The characterization of exposure assumed that enough aquatic invertebrates, fish, and aquatic plants were present in the two Animas River reaches to feed the four wildlife receptor populations evaluated in this BERA. This assumption was speculative in light of the presence of aquatic toxicity to fish and benthic invertebrates identified in the surface water and sediment. Instead, the evidence showed that these two receptor groups are impacted and therefore may not be available in the quantities needed to support viable wildlife receptor populations as assumed in the food chain models. If so, then the estimated exposures, and the resulting risks, may be more hypothetical than real.

- The COPEC tissue residues in fish were derived from the COPEC levels measured in sediment samples. This approach assumed that the entire mass of COPECs present in fish originated from the sediment. The relatively high levels of metals detected in Animas River surface water made it likely that fish also accumulated COPECs via bioconcentration through the gills. This additional pathway would have increased tissue residue levels but was not accounted for in the exposure modeling. Therefore it may be possible that the EDDs for the belted kingfisher may have been somewhat underestimated.

- The effects assessment for the wildlife receptors used published no-effect and effect TRVs to measure COPEC toxicity. The assessment endpoints focused on preserving populations, whereas TRVs are derived from data on individuals of a test species. Extrapolating individual effects to higher levels of ecological organization is inherently uncertain, particularly because these extrapolations are applied across non-related species (e.g., chicken to belted king fisher, or mouse to muskrat). The degree of uncertainty with this approach is unknown.

- The wildlife TRVs apply to all birds or mammals. This means the same COPEC-specific TRVs were used for the American dipper, mallard, and belted kingfisher. It is unknown how much more, or less, sensitive these three receptors species might be compared to the test species employed to generate the TRVs used in this BERA. Using "one-size-fits-all" TRVs creates much uncertainty about the actual toxicity of a COPEC to the target wildlife receptor. However, the TRV-derivation process is conservative by design, such that it appears more likely that the wildlife risks were overestimated rather than underestimated.

- The consistent use of conservative assumptions (such as assuming 100% of contaminant bioavailability in food items, assuming feeding in a habitat which may lack food items, relying on TRVs derived from toxicity tests using soluble or other highly bioavailable fractions of the test chemical, and using conservative "one size fits all" TRVs) most likely overestimated risk to the wildlife receptors evaluated in this BERA. As a result, the actual risk to wildlife receptors may be substantially lower than reported.

6.0 SUMMARY AND CONCLUSIONS

6.1 Introduction

The Animas River flows through the town of Silverton in San Juan County, CO. This waterway is affected by flow, which has come in contact with mineralized material, either naturally or as a result of mining activities, such as through the creation of mine adits. The affected water originates in the upper reaches of two major tributaries of the Animas River in this area, namely Cement Creek and Mineral Creek, and from other tributaries of the Animas River further upstream of Silverton. Some of the tributaries contain high levels of metals and acidity that are carried downstream to the Animas River. This evaluation did not attempt to separate natural contamination from past mining-related contamination, but assessed the total risk from all sources combined.

The surface water data represented dozens of samples collected from all the EUs between May 2009 and September 2014. The sediment data set was substantially smaller and consisted of

analytical data collected from those same waterways during five sampling events between May 2012 and September 2014. The pore water data set represented two sampling events on the Animas River and mainstem Mineral Creek in April 2014 and September 2014. The benthic invertebrate tissue data set came from one sample-collection event in September 2014. The data were reviewed to identify assessment endpoints and measures of effect, and to develop a CSM, which showed the movement of contaminants from the sources to the receptors.

The effects evaluation used CSWBs (hardness-adjusted, if necessary) for the surface water and pore water samples, plus no-effect and effect sediment benchmarks, to quantify risk to benthic invertebrates and fish exposed to surface water, pore water and sediment. No-effect and effect TRVs for birds and mammals were used to assess the toxicity of metals taken up via ingestion by wildlife receptors. Additionally, surface water and sediment toxicity tests were performed in the laboratory on samples collected from mainstem Cement Creek, mainstem Mineral Creek, and the Animas River above Cement Creek and below Mineral Creek to measure effects to benthic invertebrates (the amphipod *H. azteca*) and juvenile rainbow trout (*O. mykiss*).

Mainstem Cement Creek, mainstem Mineral Creek, and the three reaches of the Animas River were treated as separate EUs to derive RME and CTE EPCs for use in the baseline evaluation. To fine tune the exposure to aquatic community-level receptors, the surface water data were further split into three hydraulic periods, namely the pre-runoff period (February to April), runoff period (May and June), and the post-runoff period (July to November).

The EPC calculation method varied depending on the EUs, as follows:

- *Animas River above mainstem Cement Creek*: the surface water, sediment, and pore water analytical data were combined into three separate datasets to calculate COPEC-specific RME and CTE EPCs across the sampling locations.

- *Animas River between Cement and Mineral Creeks*: only two surface water analytical data were available from the two sampling locations in this reach of the river. Therefore wildlife receptors were not evaluated because sediment analytical data were required to estimate the tissue residue levels in the food items evaluated in the food chain models. The surface water analytical data were summarized by sampling location for calculating COPEC-specific RME and CTE EPCs to evaluate the fish and benthic invertebrate community.

- *Animas River below mainstem Mineral Creek*: up to several miles separate the various EUs in this lower reach of the river. As a result, this BERA assumed that wildlife receptors would not be exposed across the entire reach. Instead, the surface water, sediment, and pore water analytical data were summarized by sampling location to

calculate COPEC-specific RME and CTE EPCs for use in food chain modeling and to assess exposure to the benthic invertebrate and the fish community.

- *Mainstem Cement Creek*: thix BERA did not evaluate wildlife receptors foraging in this EU because the SLERA showed that current chemical conditions in this waterway are too degraded to provide forage for wildlife. The surface water and sediment data from the two sampling locations at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

- *Mainstem Mineral Creek*: this BERA did not evaluate wildlife receptors foraging in this EU because current chemical conditions in this waterway are too degraded to provide enough forage for wildlife. The surface water and sediment data from the sampling location at the mouth of the creek were used to calculate COPEC-specific RME and CTE EPCs to evaluate risk to the fish and benthic invertebrate community.

Exposure to the four wildlife receptor species foraging in the reaches of the Animas River above mainstem Cement Creek and below mainstem Mineral Creek was quantified using a food chain model which calculated RME and CTE EDDs based on ingesting surface water, sediment, and food items. The food items consisted of benthic invertebrates, fish, and aquatic plants, depending on the target wildlife species. The contaminant levels in the benthic invertebrates were based on measured values (except at sampling locations A73B and A75B), whereas the contaminant levels in fish and plants were estimated by multiplying the sediment RME and CTE COPEC levels by published COPEC-specific sediment-to-biota accumulation factors or by using published regression equations.

Risk was quantified using the HQ method, which compares measured exposures (i.e., RME and CTE surface water, sediment, and pore water EPCs) or estimated exposures (RME and CTE wildlife EDDs) to CSWBs, and no-effect and effect sediment benchmarks and wildlife TRVs.

A COPEC-specific HQ was then calculated using the following general equation:

HQ = EPC or EDD/benchmark or TRV

Where:

HQ	=	Hazard Quotient (unitless)
EPC	=	RME and CTE Exposure Point Concentration (µg/L or mg/Kg)
EDD	=	RME and CTE Estimated Daily Dose (mg/kg bw-day)
Benchmark	=	CSWBs or sediment no effect and effect benchmarks (µg/L or mg/kg, respectively)
TRV	=	no effect and effect wildlife Toxicity Reference Value (mg/Kg bw-day)

HQs equal to or above one identified a potential for ecological risk, whereas HQs below one were used to eliminate chemicals with assurance that they did not pose a risk.

Besides assessing the potential impacts associated with RME and CTE exposures, the risk characterization for fish and benthic invertebrates also viewed each surface water and sediment sample as an individual exposure event in time. HQs were calculated for all available surface water and sediment samples and were used to form "scatter plots" by sampling station and hydraulic period (i.e., pre-runoff, runoff, and post-runoff). Those plots were then used to identify patterns of risk across the waterways and hydraulic periods.

Finally, toxicity data from benthic invertebrates and fish exposed to surface water and sediment in the laboratory were evaluated statistically to determine which of the observed responses were significantly different from laboratory control samples. Benthic community data collected in September 2014 were graphically analyzed and compared to historic data collected from the same sampling locations in the past. Data from past fish surveys were also reviewed

Uncertainty was inherent in this BERA because many assumptions were made in order to proceed with the investigation. These assumptions affected all aspects of the assessment including the CSM, the effects analysis, the exposure analysis, and the risk characterization. The uncertainty analysis identified and discussed the major assumptions made in this BERA. It also provided a short description to determine if the assumptions were likely to have overestimated or underestimated the potential for ecological risk. The end result was a balanced overview of uncertainty to help risk managers understand the full extent of potential ecological risk to receptors living or feeding in mainstem Cement Creek, mainstem Mineral Creek, and the Animas River at and below Silverton.

6.2 Risk conclusions for benthic invertebrates

Taken together, the four independent measurement endpoints evaluated in this BERA (i.e., sediment HQs, pore water HQs, sediment toxicity, and community structure and function) indicated that the benthic invertebrate communities in the Animas River between A60 and BB, and in mainstem Cement and Mineral Creeks, were all impacted. The two creeks were the most impaired. Additionally, comparing four benthic community metrics collected from the Animas River in September 2014 against historical data on those same four metrics indicated that the benthic invertebrate community in the Animas River has not consistently improved over the last decade, with the possible exception at sampling location A75D.

6.3 Risk conclusions for fish

- **Mainstem Cement Creek:**

The chemical conditions in surface water from mainstem Cement Creek were highly toxic to fish, particularly due to low pH and high Al, and to a lesser extent by the presence of Cd, Cu, and Zn. The toxicity tests showed that surface water collected from this EU in November 2012 (i.e., post-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence suggested that the fish community in mainstem Cement Creek (if present) would experience lethal stress under current conditions.

- **Mainstem Mineral Creek:**

The chemical conditions in surface water from mainstem Mineral Creek appeared less severe than in mainstem Cement Creek for the local fish community. However, serious pH drops during the pre-runoff period coupled with high Al levels during the pre-runoff and post-runoff periods suggested that fish may experience high stress in the winter, summer, and fall, but that survivors could possibly recover during the rest of the year (spring). The toxicity tests showed surface water collected from this EU in November 2012 (i.e., post-runoff period) and April 2013 (pre-runoff period) was acutely toxic to juvenile rainbow trout. The preponderance of evidence suggested that the fish community in mainstem Mineral Creek (if present) would likely experience high stress under current conditions.

- **Animas River above mainstem Cement Creek:**

The chemical conditions in surface water from this reach of the Animas River between A60 and A68 indicated the presence of one or more sources of metal contamination located further upstream in the watershed. The chemical signature of the surface water suggested that chronic

toxicity to the fish community was possible, particularly due to the presence of Al, Cd, and Zn. Low pH, on the other hand, was not an issue in this reach. The presence of significant acute toxicity measured in juvenile rainbow trout acutely exposed to surface water from this reach further confirms the results of the chemical analyses. The preponderance of evidence suggested that the fish community in this reach of the Animas River could be stressed during much of the year. This conclusion was supported by the fact that daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at location A56 (upstream of A60) showed the presence of potentially severe chronic toxicity associated with dissolved Al, Cd, Cu, Pb, and Zn during the pre-runoff and runoff periods.

- **Animas River between mainstem Cement Creek and mainstem Mineral Creek**

Little chemical information on the quality of the surface water was available because only two samples were collected and no acute toxicity testing was performed. The limited amount of data suggested that this reach of the Animas River was likely to be lethal to fish, mostly due to low pH and high levels of aluminum, with secondary stress caused by Cd and Zn.

- **Animas River below mainstem Mineral Creek**

The chemical signature of the surface water in this reach of the Animas River reflected the major inputs from mainstem Mineral and Cement Creek, and the reach of the Animas River above mainstem Cement Creek. Surface water samples collected from sampling location A72 during the pre and post-runoff periods were acutely toxic to juvenile rainbow trout. Surface water samples collected during the same two hydraulic periods from the EUs further downstream did not show acute toxicity, suggesting that the effect had been "diluted out". However, the preponderance of evidence shows that Al, Cd, and Zn in surface water may exert chronic effects on the fish community to at least the BB EU located about 30 miles downstream from Silverton. This conclusion was supported by two additional lines of evidence:

  - Daily surface water samples collected between April and July 2014 using "MiniSipper" sampling devices positioned at locations A73, A75D and BB showed the presence of low-grade but multi-week chronic toxicity associated with dissolved Al, Cd, and Zn during the pre-runoff and runoff periods.

  - A fisheries survey performed by the Colorado Division of Wildlife (CDOW) in 2010 on the Animas River in the vicinity of sampling locations A72, A73, and A75D/A75B showed a severe decline of the trout populations at all three locations between 2005 and 2010. The CDOW ascribed this collapse to a drastic reduction in surface water quality apparently associated with the discontinuance of a water treatment project in the Gladstone area on Cement Creek upgradient from Silverton. A 2014 follow-up fisheries

survey by the CDOW in the vicinity of sampling location A75D/A75B showed that the trout population had essentially been extirpated.

6.4 Risk conclusions for wildlife receptors

- **Animas River above mainstem Cement Creek**

A potential for minimal risk to wildlife receptors was identified for Zn (American dipper) and Pb (belted kingfisher). The American dipper was also used as a surrogate species to perform a conservative assessment of risk to the southwestern willow flycatcher, a federally and state-listed bird species. The evidence did not suggest that this species was at substantial risk from foraging in the Animas River above mainstem Cement Creek between sampling location A60 and A68.

- **Animas River below mainstem Mineral Creek**

The potential for risk to wildlife receptors in this reach of the Animas River was restricted to Cu in the American dipper at sampling locations A73B and A75B, with minor risk from Cu to the mallard (100% diet only) at the same two locations. The remaining COPECs were of no concern to any of the wildlife receptors. Benthic invertebrates were not collected for tissue residue analysis from sampling locations A73B and A75B. Instead, the levels of metals in benthic tissues at these two locations were estimated using conservative published sediment-to-benthic invertebrate regression models and uptake factors for use in the food chain model. It is noteworthy that the only two sampling locations with excessive risk from Cu were A73B and A75B. Given this pattern, it was concluded that the risk from Cu was hypothetical and unlikely to be realized in the field.

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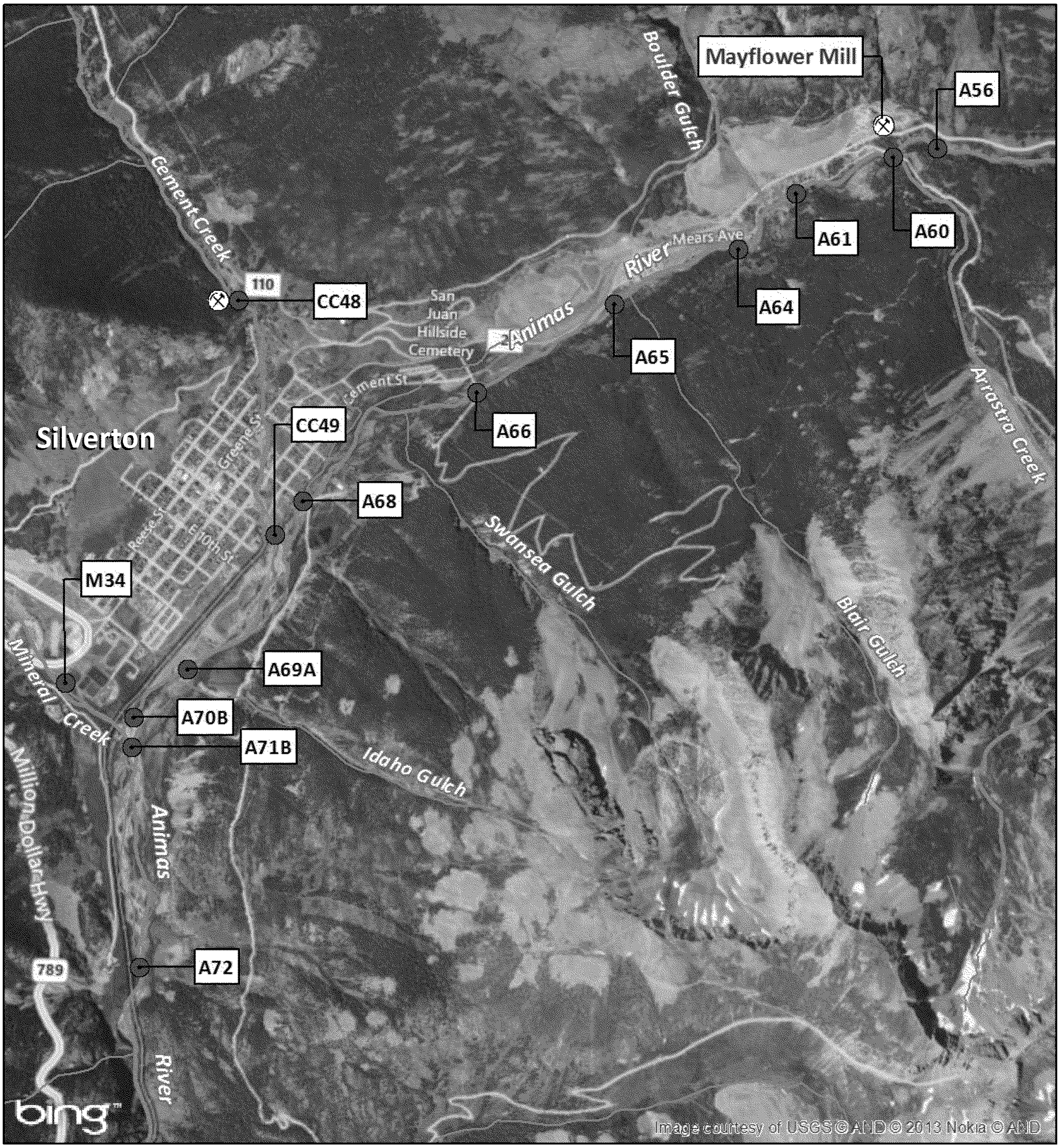


Figure 1.1

Sampling Locations on the Animas River Upstream and Across from Silverton, CO

Sample Locations

Mine Locations

Rivers and Streams

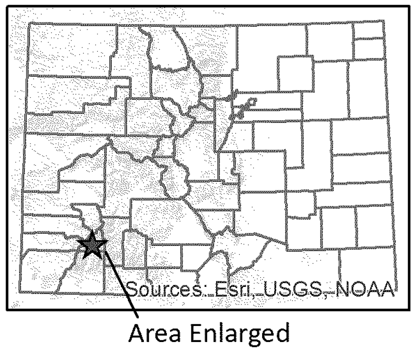
Date: January 30, 2014

Data Sources:
Sample Locations: U.S. EPA Region 8 (2013)
Mine Locations: U.S. EPA and ESAT (2012)
Rivers and Streams: CDOW 1:24k (2004)
Image: Microsoft Bing web service (2014)

Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

0 1,000 2,000 Feet

N



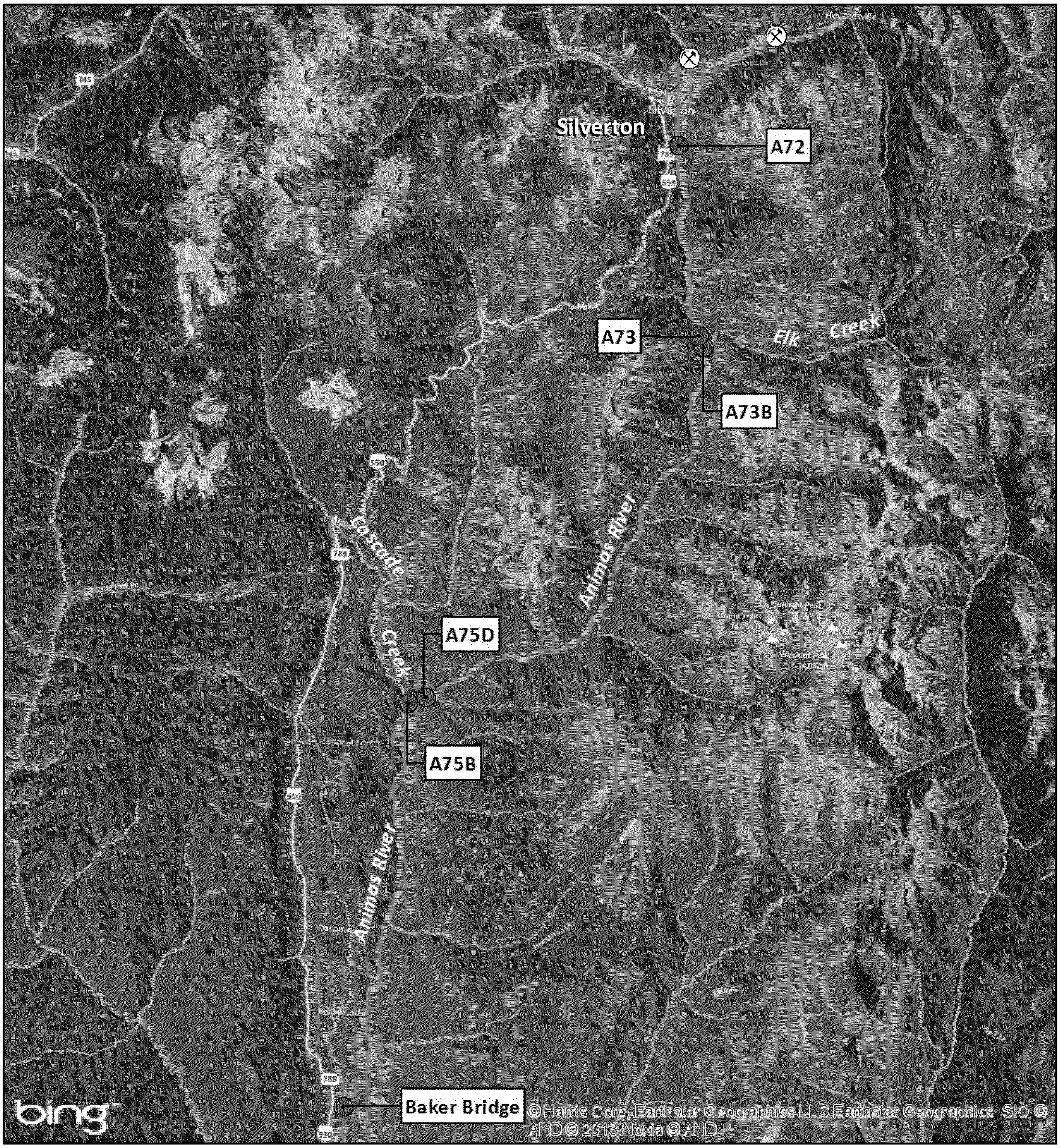


Figure 1.2

Sampling Locations on the Animas River Downstream from Silverton, CO

Sample Locations

Mine Locations

Rivers and Streams

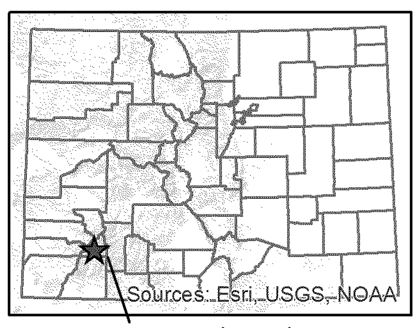
Date: January 30, 2014

0 1 2 Miles

Data Sources:
Sample Locations: U.S. EPA Region 8 (2013)
Mine Locations: U.S. EPA and ESAT (2012)
Rivers and Streams: CDOW 1:24k (2004)
Image: Microsoft Bing web service (2014)

Coordinate System/Projection:
UTM Zone 13 North, NAD 83, Meters

Colorado



Area Enlarged

FIGURE 2.1
Site conceptual model for the aquatic habitats and receptors evaluated in the BERA
Baseline Ecological Risk Assessment
Upper Animas Mining District

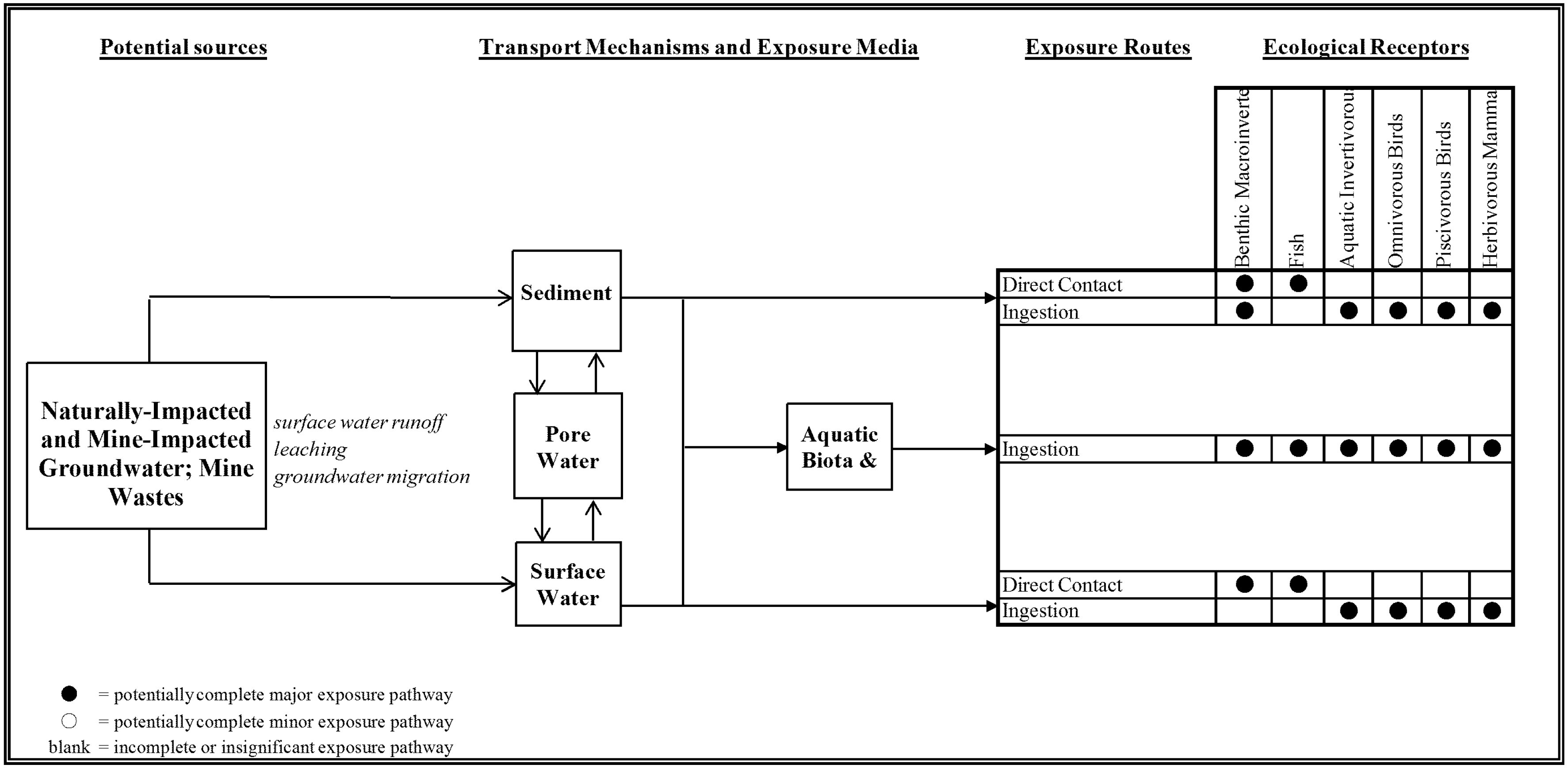
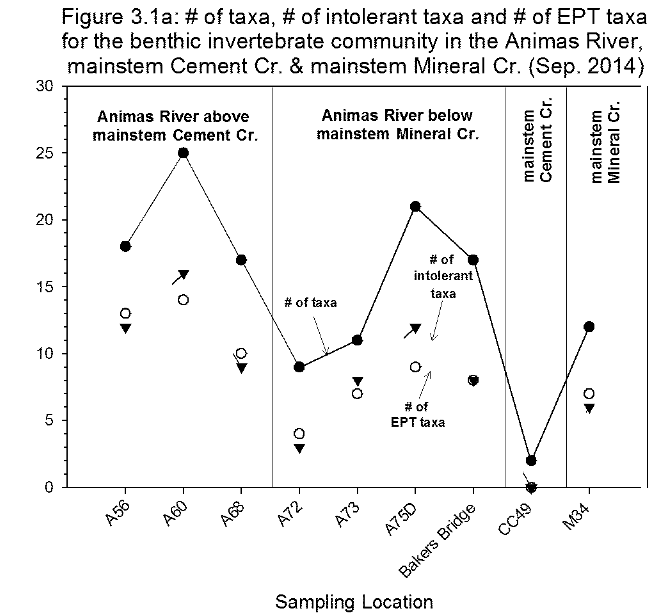
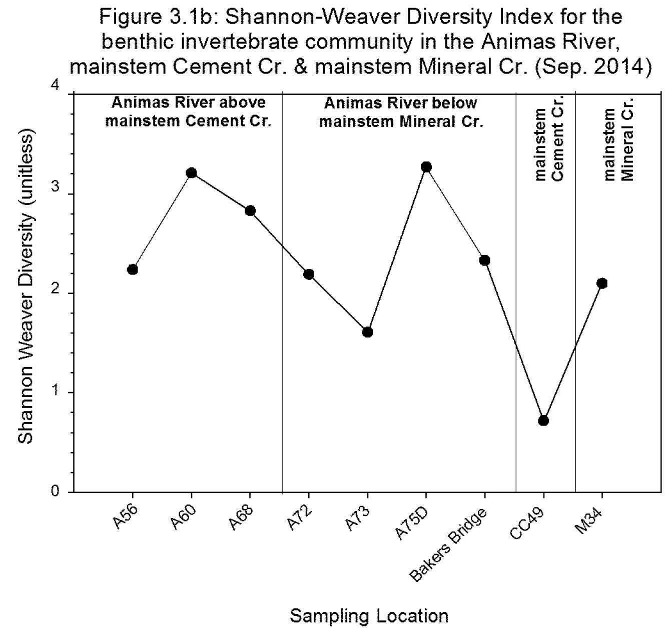
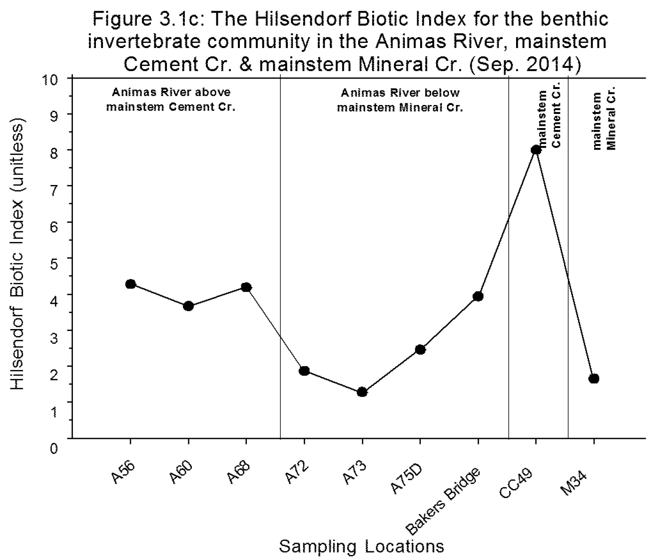


Figure 3.1: Summary of select benthic invertebrate community data collected in September 2014 from the Animas River, main stem Cement Creek, and main stem Mineral Creek







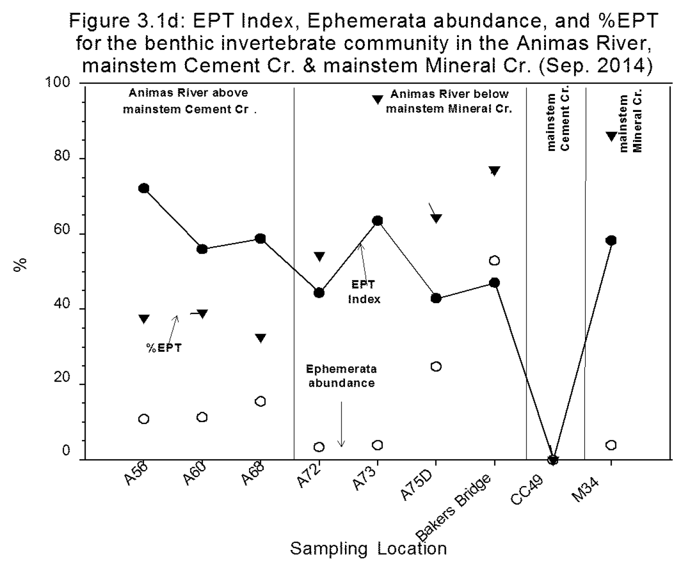


Figure 3.1 (cont'd): Summary of select benthic invertebrate community data collected in September 2014 from the Animas River, main stem Cement Creek, and main stem Mineral Creek

Figure 3.5: Filterers, scrapers, and clingers in the benthic community in the Animas River, mainstem Cement Creek, and mainsten Mineral Creek (Sep. 2014)

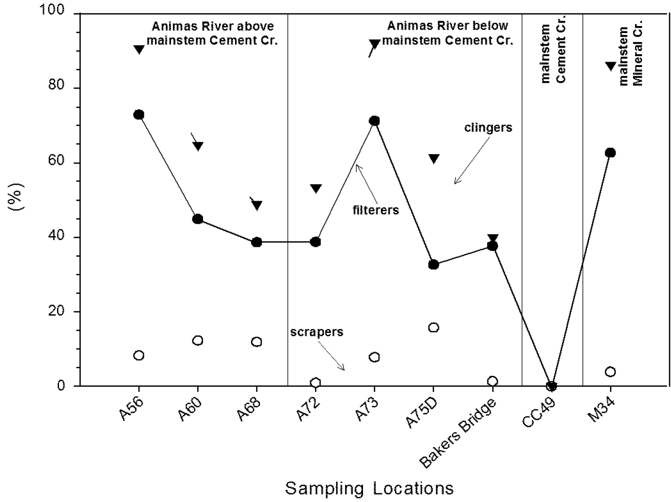


Figure 5.1: Geometric mean no effect and effect HQs for the benthic invertebrate community exposed to sediment in the Animas River above Cement Creek and below Mineral Creek

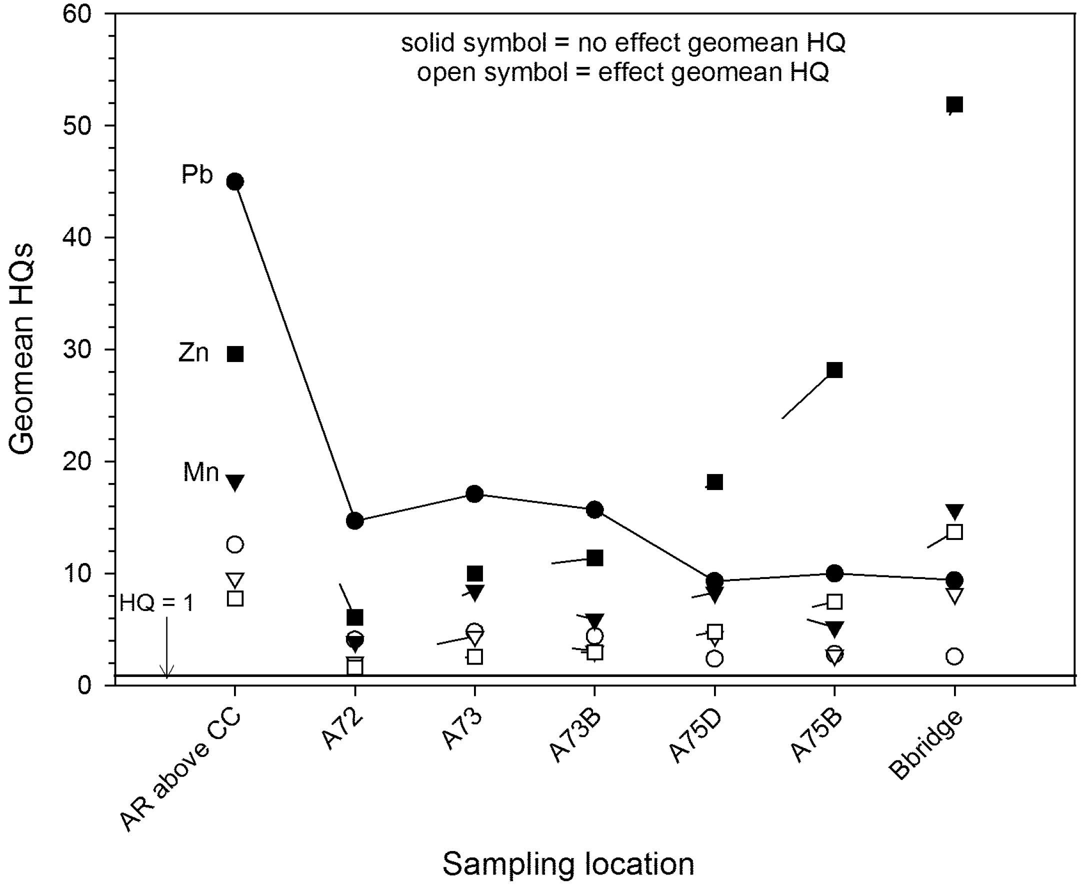


Figure 5.3: Comparison of four benthic community metrics measured in 2014 at three sampling locations in the Animas River against the same metrics measured in 2004-2010

Figure 5.3a: Relative change over time in the number of benthic invertebrate taxa in the Animas River at sampling locations A68, A72 and A75D

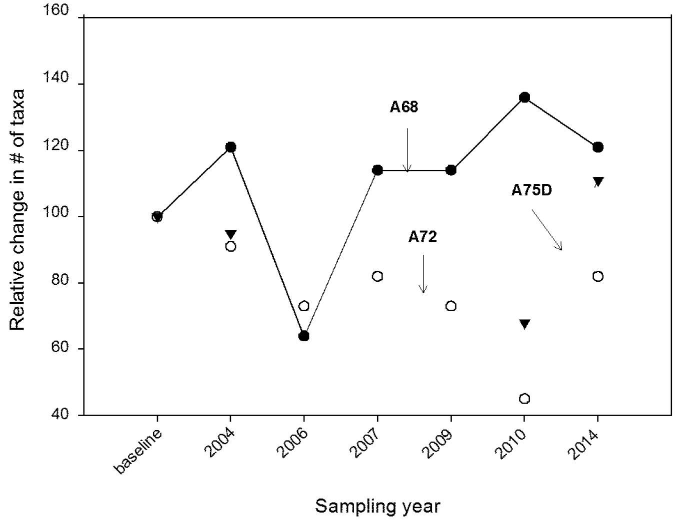


Figure 5.3b: Relative change over time in the number of EPT taxa in the Animas River at sampling locations A68, A72 and A75D

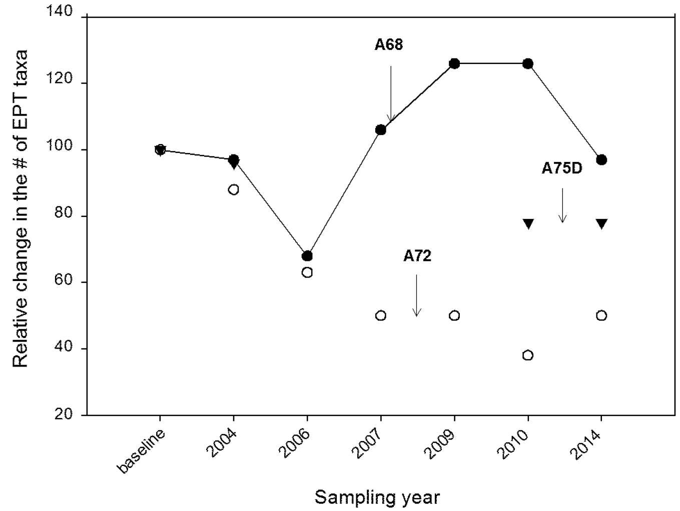


Figure 5.3c: Relative change over time in the % of EPT taxa in the Animas River at sampling locations A68, A72 and A75D

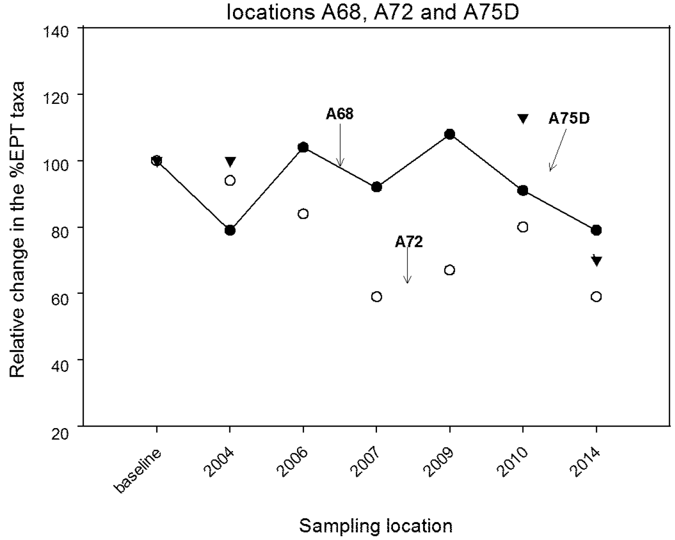


Figure 5.3d: Relative change over time in the Shannon diversity index in the Animas River at sampling locations A68, A72 and A75D

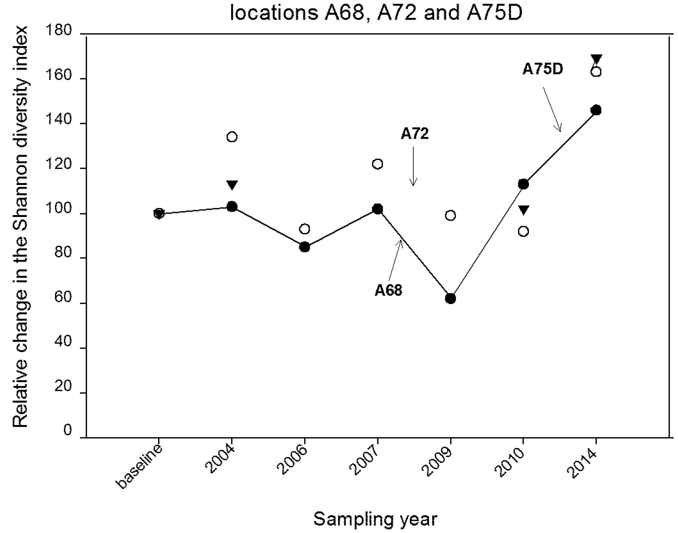


Figure 5.4: Scatter plots of pH in surface water

Figure 5.4.a: pH in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60-A68)

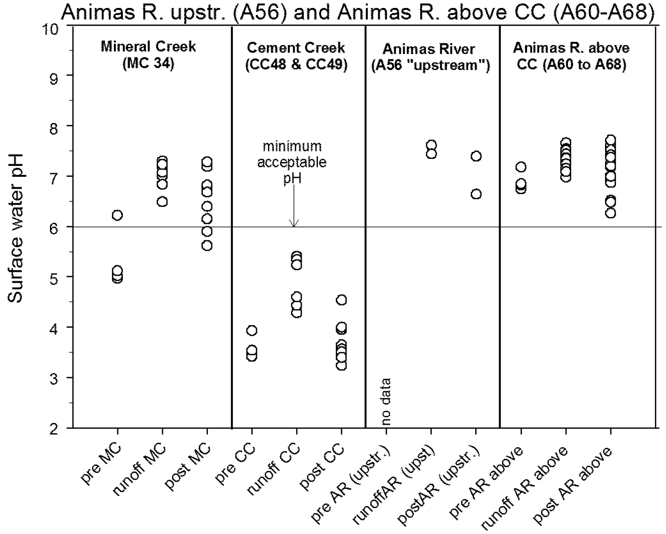


Figure 5.4.b: pH in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

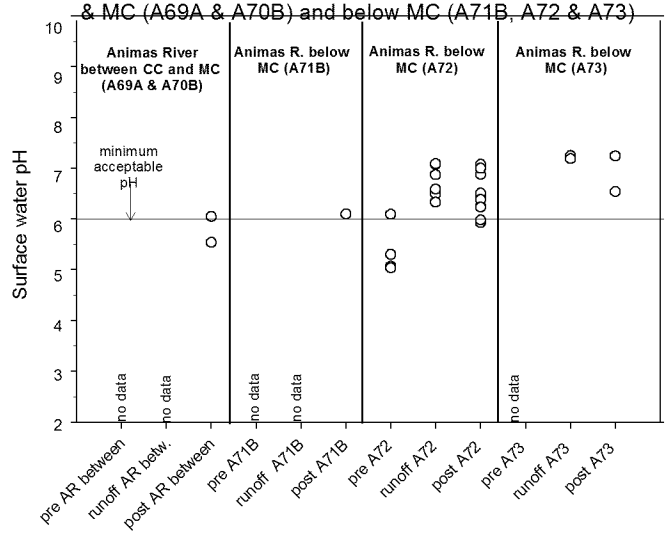


Figure 5.4.c: pH in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below Mineral Creek (A73B, A75D, A75B, and Bakers Bridge)

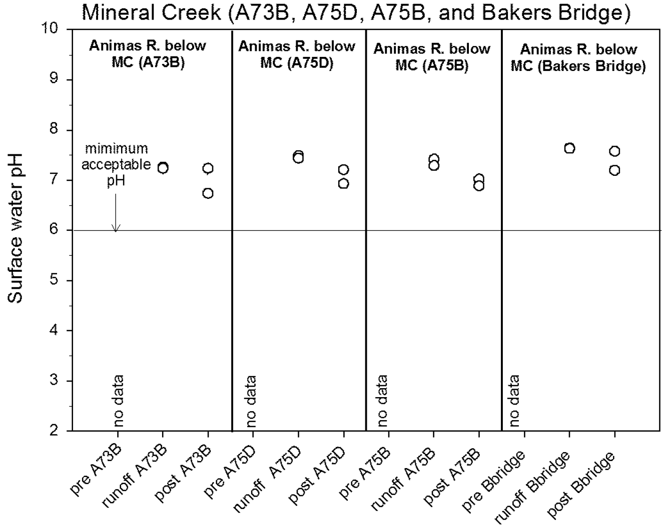
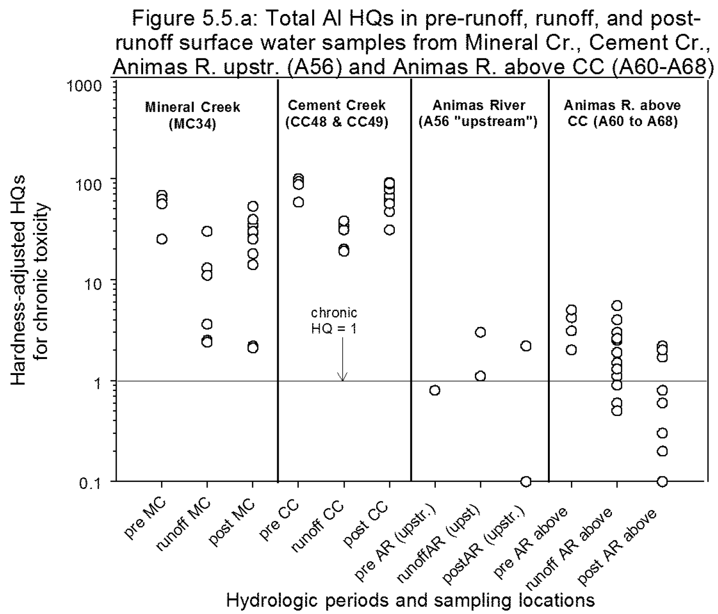
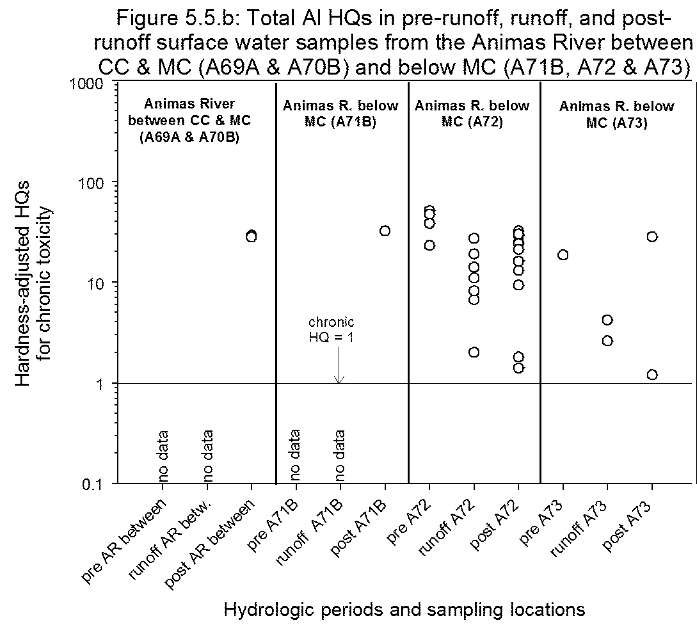


Figure 5.5: Scatter plots of total Al HQs in surface water





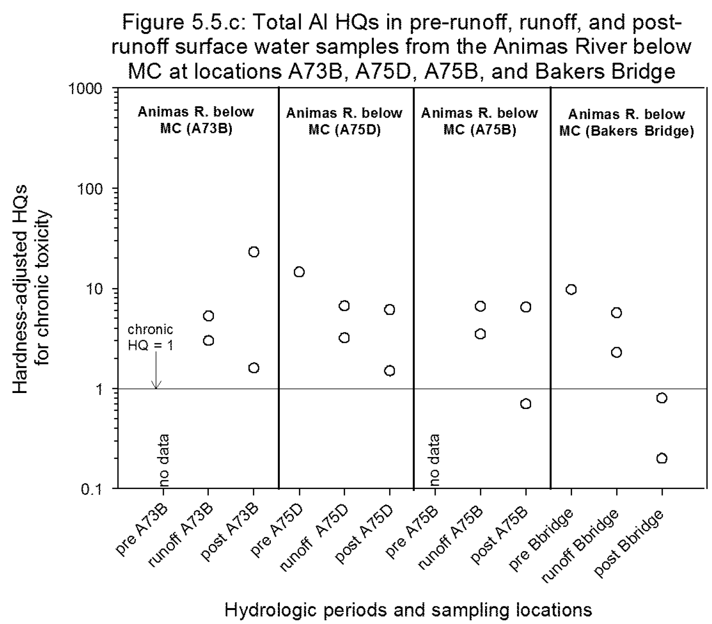


Figure 5.6: Scatter plots of dissolved Cd HQs in surface water

Figure 5.6.a: Dissolved Cd HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

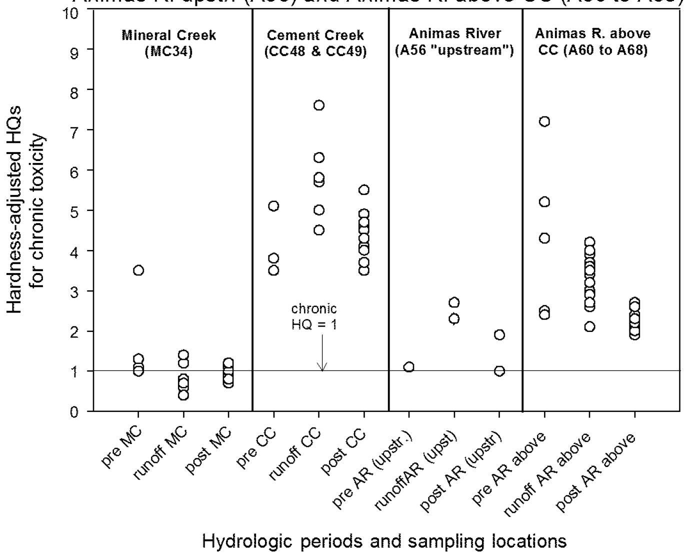


Figure 5.6.b: Dissolved Cd in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

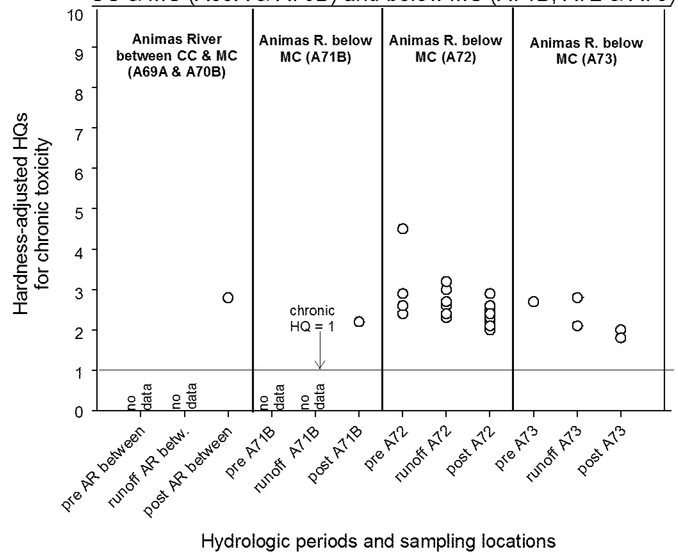


Figure 5.6.c: Dissolved Cd HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

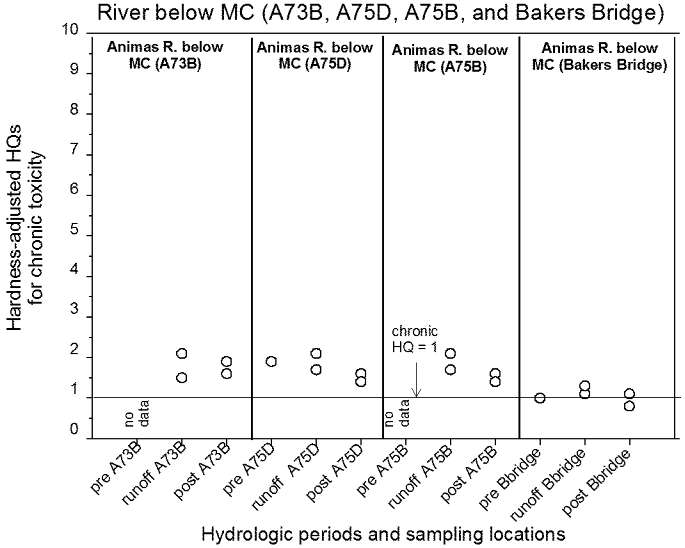


Figure 5.7: Scatter plots of dissolved Cu HQs in surface water

Figure 5.7.a: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

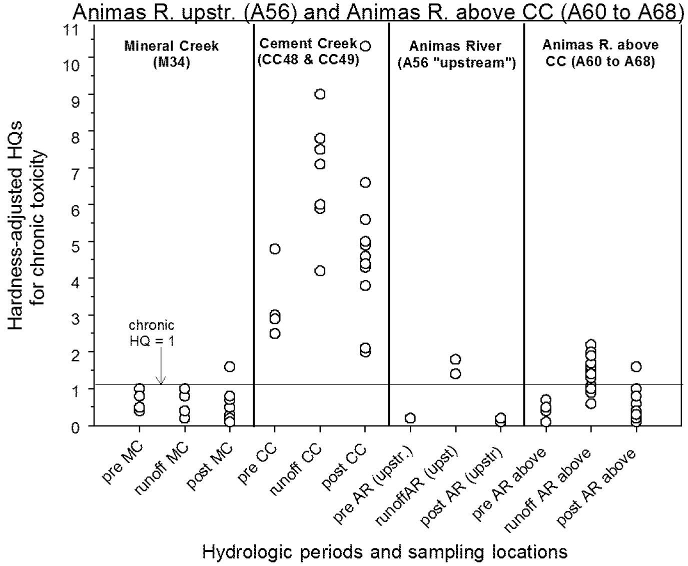


Figure 5.7.b: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

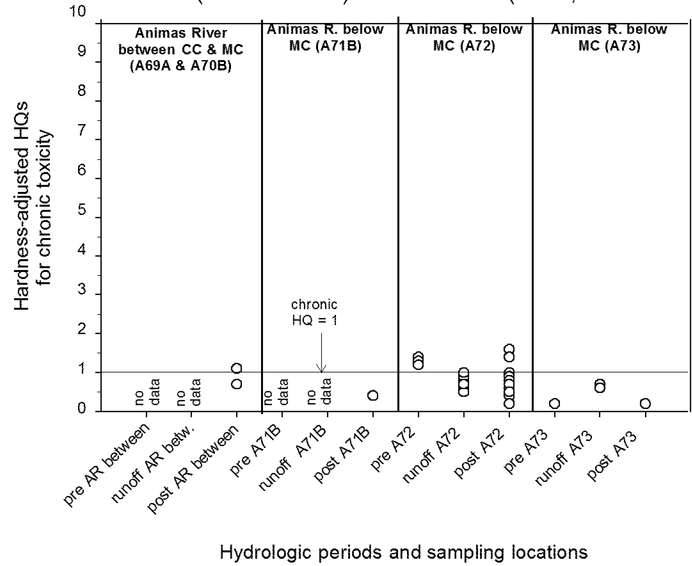


Figure 5.7.c: Dissolved Cu HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

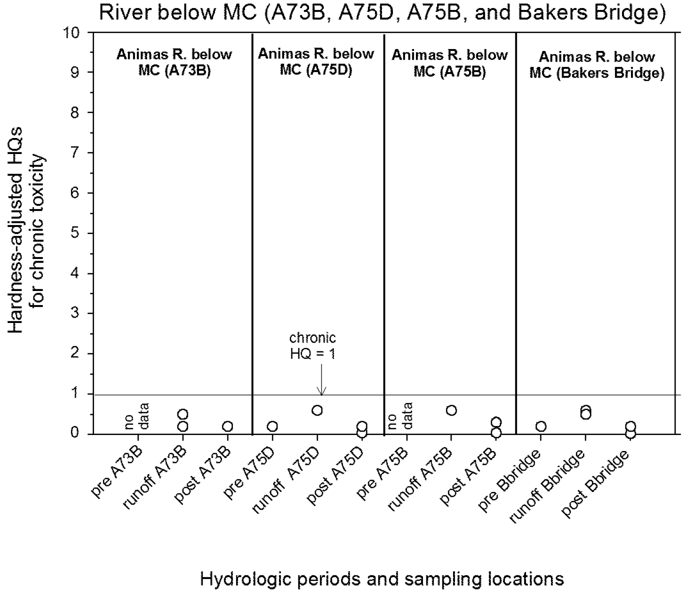


Figure 5.8: Scatter plots of dissolved Mn HQs in surface water

Figure 5.8.a: Dissolved Mn HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

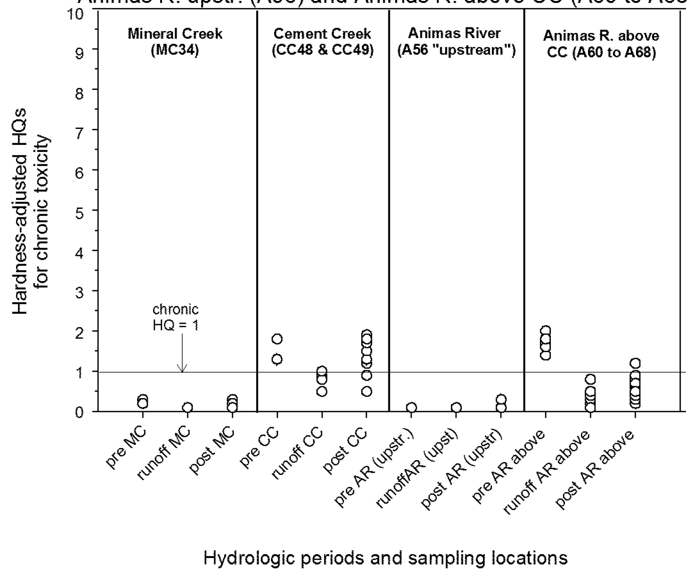


Figure 5.8.b: Dissolved Mn HQs in pre-runof, runoff, and post-runoff surface water samples from the Animas River between CC and MC (A69A & A70B) and below MC (A71B, A72 & A73)

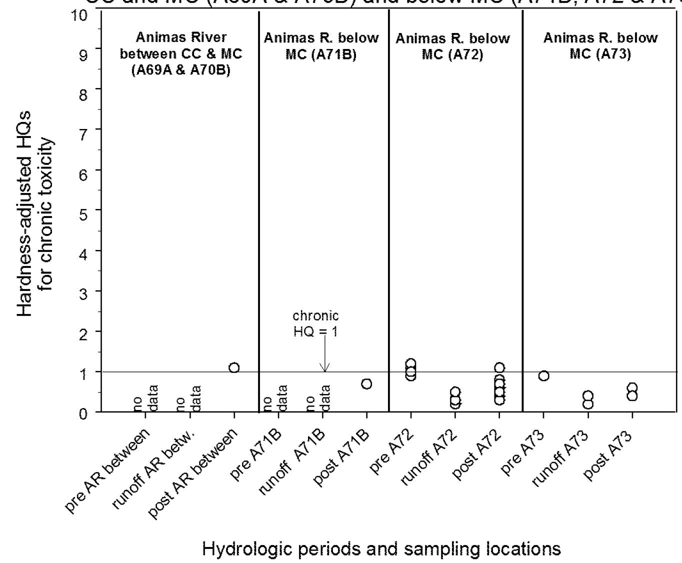


Figure 5.8.c: Dissolved Mn HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

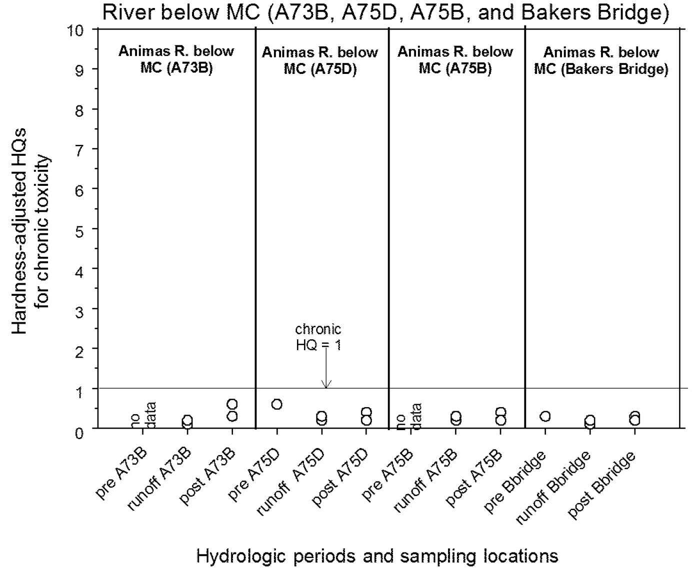


Figure 5.9: Scatter plots of dissolved Pb HQs in surface water

Figure 5.9.a: Dissolved Pb HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

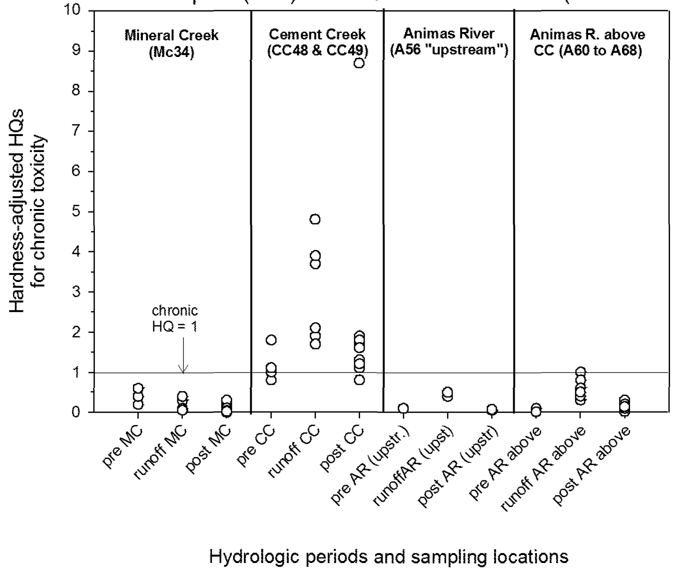


Figure 5.9.b: Dissolved Pb HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC and MC (A69A & A70B) and below MC (A71B, A72 & A73)

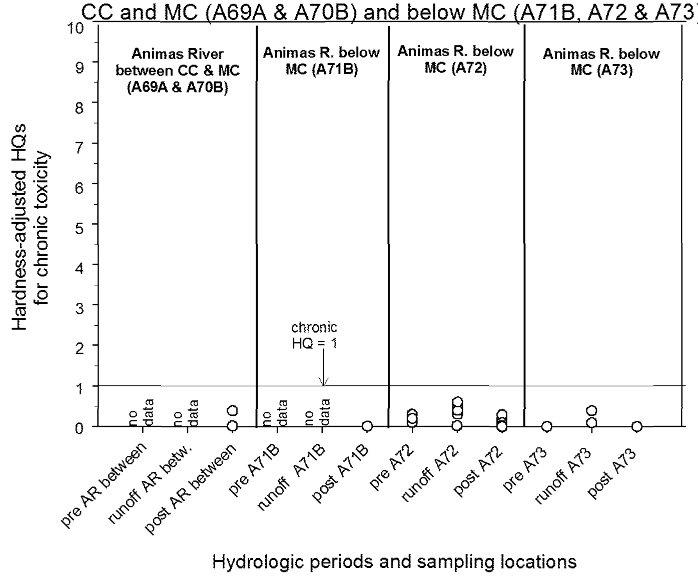


Figure 5.9.c: Dissolved Pb HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

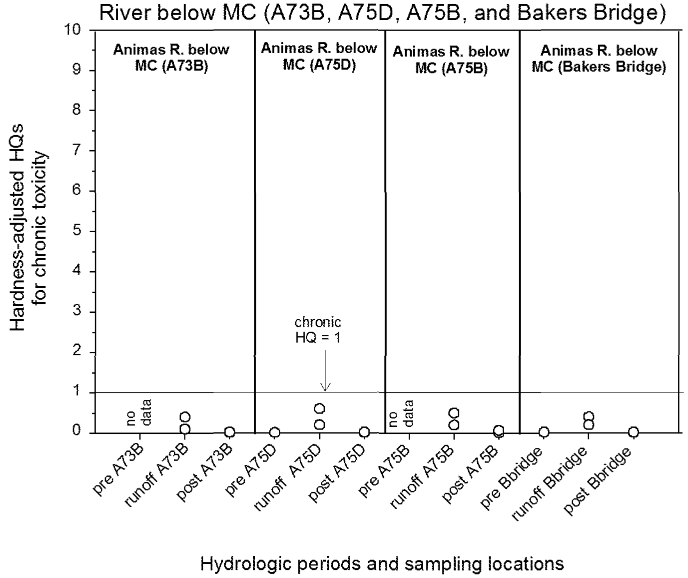


Figure 5.10: Scatter plots of dissolved Zn HQs in surface water

Figure 5.10.a: Dissolved Zn HQs in pre-runoff, runoff, and post-runoff surface water samples from Mineral Cr., Cement Cr., Animas R. upstr. (A56) and Animas R. above CC (A60 to A68)

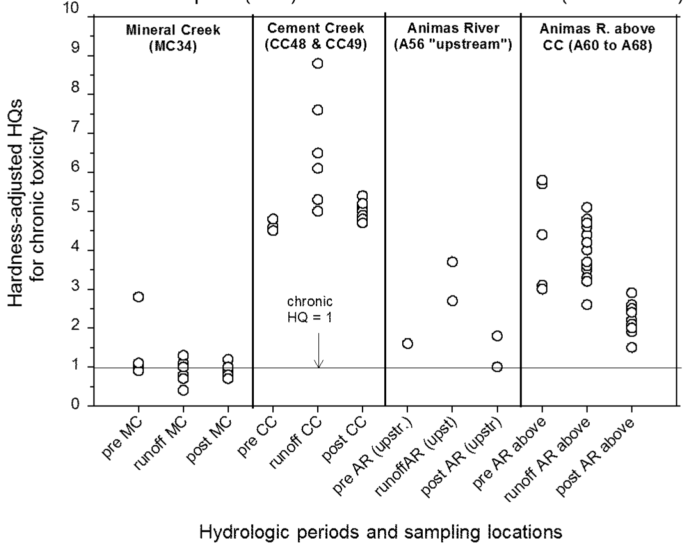


Figure 5.10.b: Dissolved Zn HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River between CC & MC (A69A & A70B) and below MC (A71B, A72 & A73)

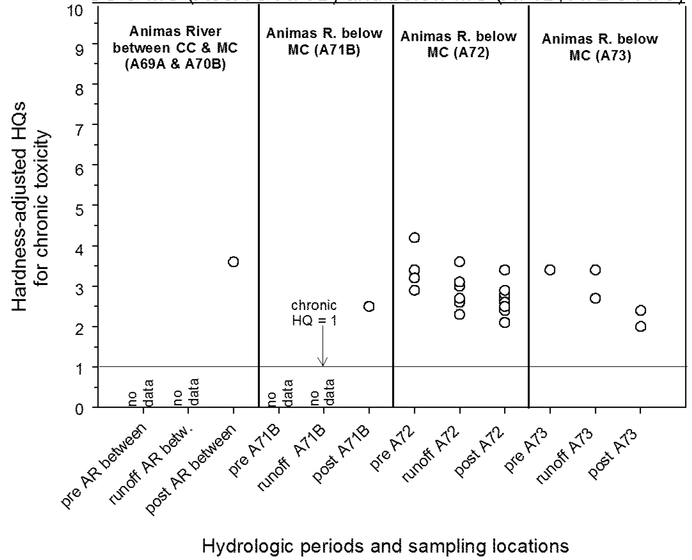


Figure 5.10.c: Dissolved Zn HQs in pre-runoff, runoff, and post-runoff surface water samples from the Animas River below MC (A73B, A75D, A75B, and Bakers Bridge)

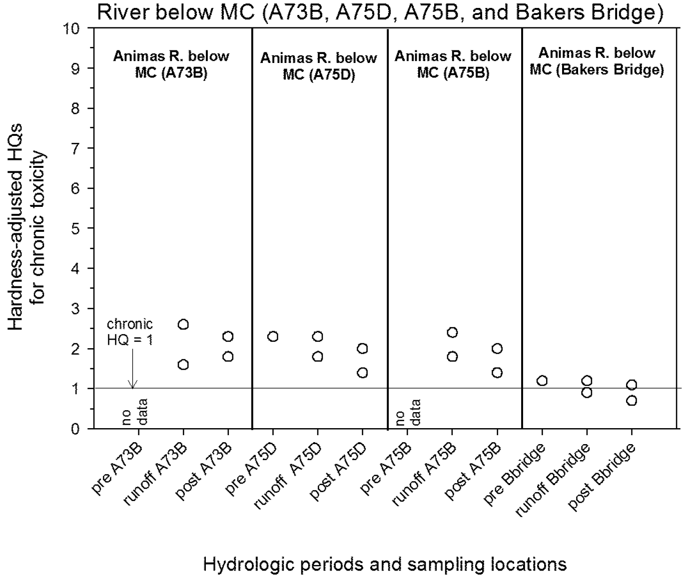


Figure 5.11: Scatter plots of dissolved metals chronic HQs in surface water samples collected using MiniSipper sampling devices in 2014

Figure 5.11a: Chronic HQs for dissolved Al in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

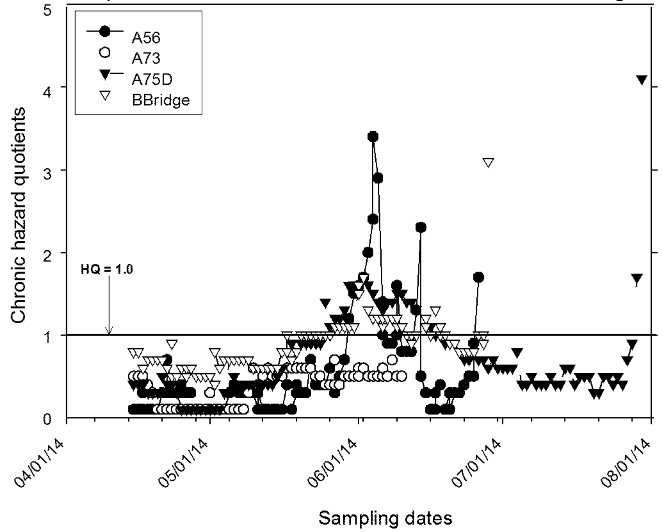


Figure 5.11b: Chronic HQs for dissolved Cd in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

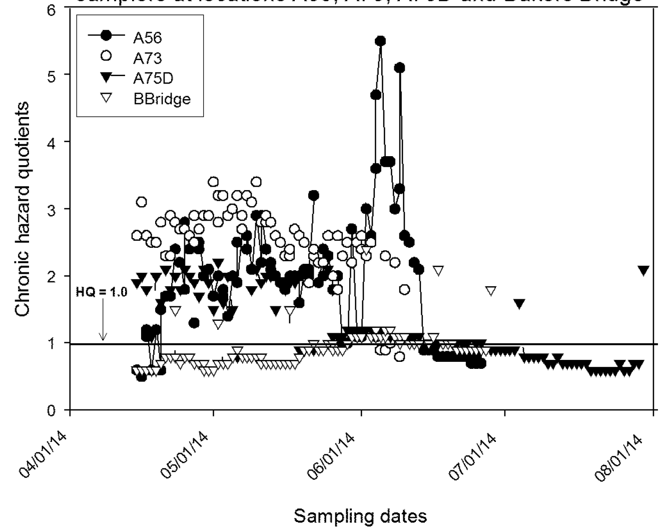


Figure 5.11c: Chronic HQs for dissolved Cu in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

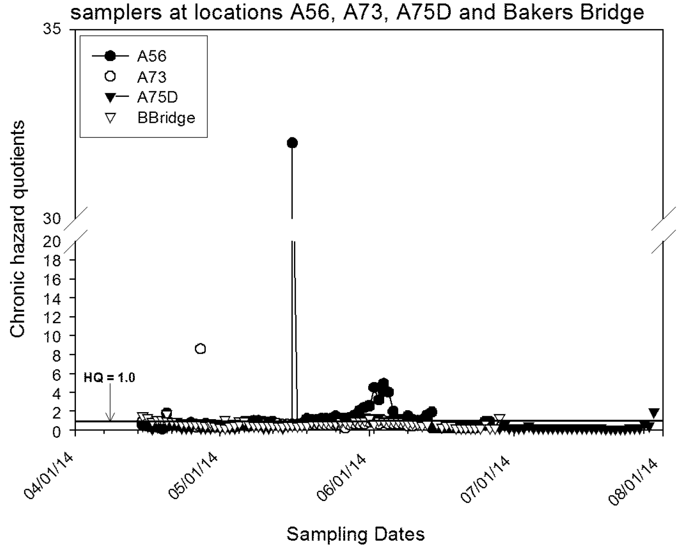


Figure 5.11d: Chronic HQs for dissolved Pb in surface water collected in 2014 from the Animas River using MiniSipper samplers at locations A56, A73, A75D and Bakers Bridge

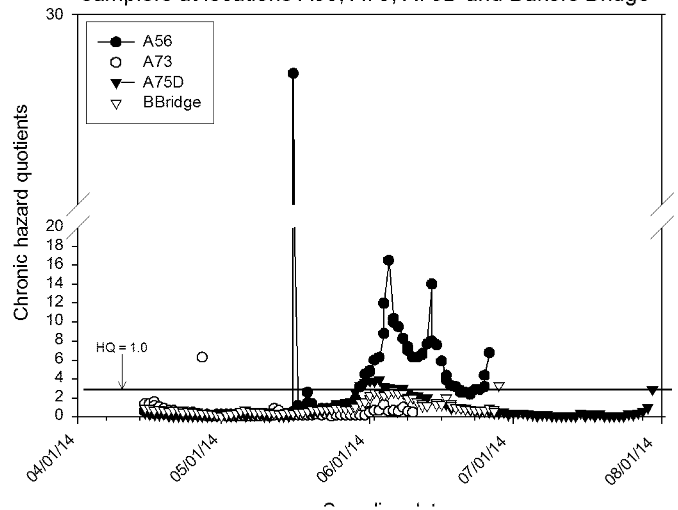


Figure 5.11 (cont'd): Scatter plots of dissolved metals chronic HQs in surface water samples collected using MiniSipper sampling devices in 2014

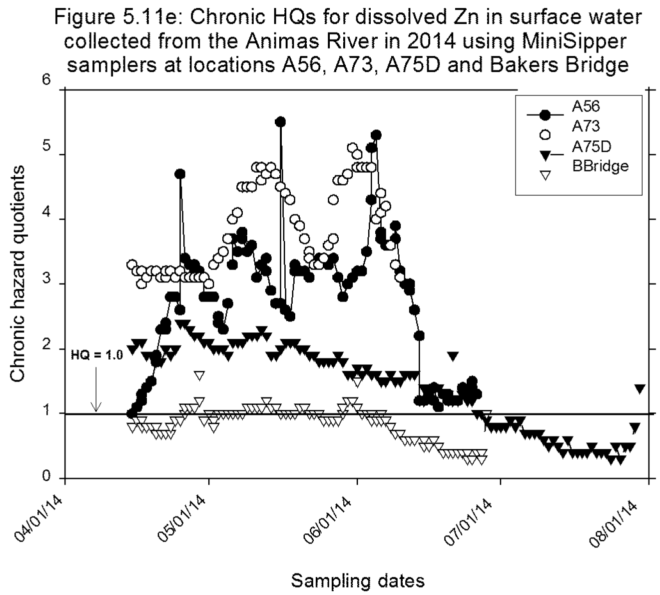


Figure 5.12: Geometric mean RME and CTE HQs for the four wildlife receptors evaluated using food chain modeling

Figure 5.12a: G eom etric m ean RM E and CTE HQ s for the Am erican Dipper feeding in the Anim as River above Cem ent Creek and below M ineral Creek

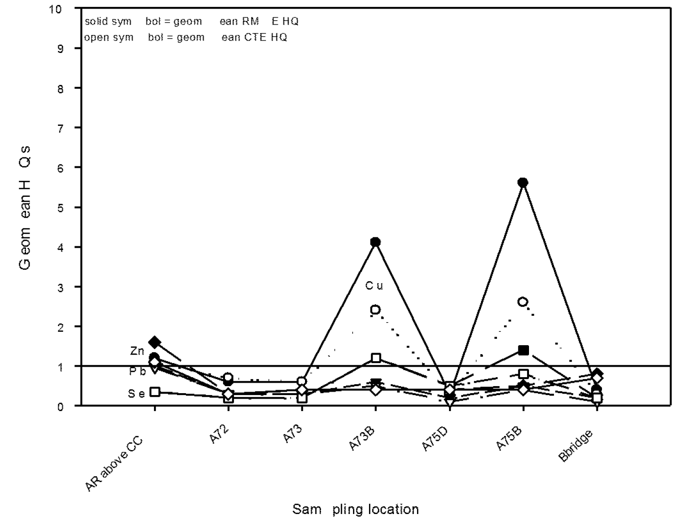


Figure 5.12b: G eom etric m ean R M E and C TE H Q s for the belted kingfisher feeding in the Anim as R iver above C em ent C reek and below M ineral C reek

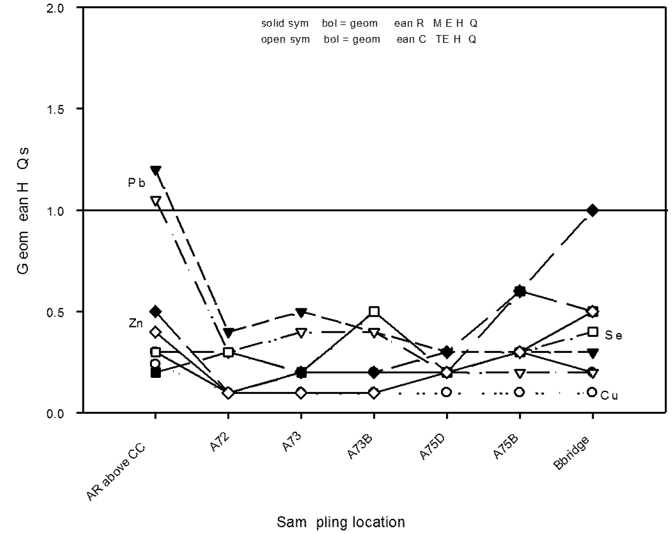


Figure 5.12c: G eom etric m ean R M E and C TE H Q s for the m uskrat feeding in the Anim as R iver above C em ent C reek and below M ineral C reek

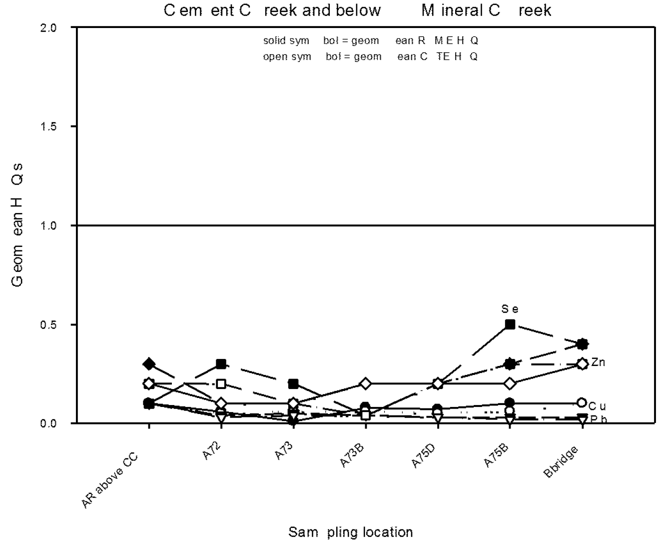


Figure 5.12d: G eom etric m ean R M E and C TE H Q s for the m allard feeding on a 100% benthic invertebrate diet in the Anim as R iver above C em ent C r. and below M ineral C r.

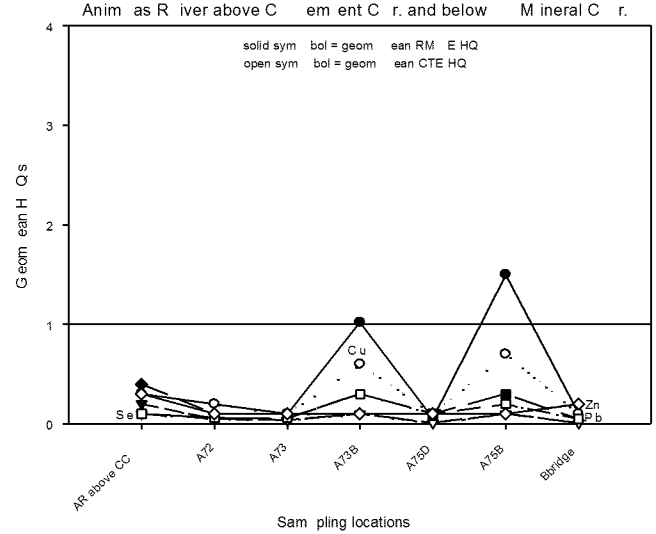


Figure 5.12: Geometric mean RME and CTE HQs for the four wildlife receptors evaluated using food chain modeling

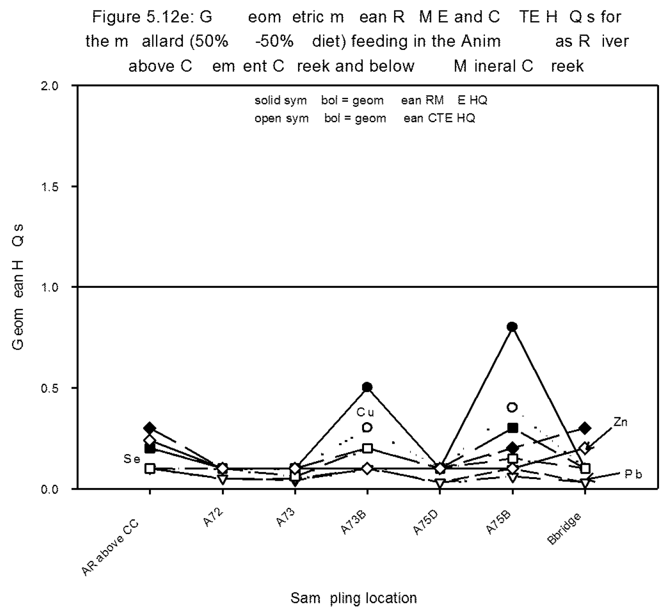


Table 2.1
Summary of the 2009-2014 surface water sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																		
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek							Mainstem Cement Creek		Mainstem Mineral Creek
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10							√				√						√		√
	Mar-10							√				√						√		√
	Apr-10							√				√						√		√
	Mar-11							√				√						√		√
	Apr-14	√						√					√		√		√			
runoff period	May-09							√				√						√		√
	Jun-09							√				√						√		√
	Jun-10							√				√						√		√
	Jun-11							√				√						√		√
	May-12							√				√						√		√
	May-13	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√
	May-14	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√
post-runoff period	Jul-09							√				√						√		√
	Aug-09							√				√						√		√
	Sep-09							√				√						√		√
	Nov-09							√				√						√		√
	Jul-10							√				√						√		√
	Sep-10							√				√						√		√
	Nov-10							√				√						√		√
	Jul-11							√				√						√		√
	Aug-11							√				√						√		√
	Sep-11							√				√						√		√
	Oct-11							√				√						√		√
	Oct-12	√						√	√	√	√	√	√	√	√	√	√	√	√	√
	Sep-14	√	√	√	√	√	√	√				√	√	√	√	√	√	√		√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 2.2
Summary of the 2009-2014 sediment sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																		
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek							Mainstem Cement Creek		Mainstem Mineral Creek
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10																			
	Mar-10																			
	Apr-10																			
	Mar-11																			
	Apr-14	√	√	√	√	√	√	√				√	√		√		√			
runoff period	May-09																			
	Jun-09																			
	Jun-10																			
	Jun-11																			
	May-12							√				√								
	May-13	√	√	√	√	√	√	√				√	√	√	√	√	√			
	Jun-14																			
post-runoff period	Jul-09																			
	Aug-09																			
	Sep-09																			
	Nov-09																			
	Jul-10																			
	Sep-10																			
	Nov-10																			
	Jul-11																			
	Aug-11																			
	Sep-11																			
	Oct-11																			
	Oct-12	√						√				√	√	√	√	√	√		√	√
	Sep-14	√	√	√	√	√	√	√				√	√	√	√	√	√			√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 2.3
Summary of the 2009-2014 sediment pore water sampling efforts at select locations in the Upper Animas River, Cement Creek, and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

		Animas River																Mainstem Cement Creek		Mainstem Mineral Creek
		Above mainstem Cement Creek							Between Cement & Mineral Creeks		Below mainstem Mineral Creek									
	Sample Date	A56[a]	A60	A61	A64	A65	A66	A68	A69A	A70B	A71B	A72	A73	A73B	A75D	A75B	Bbridge	CC48	CC49	M34
pre-runoff period	Feb-10																			
	Mar-10																			
	Apr-10																			
	Mar-11																			
	Apr-14	√	√	√	√	√	√	√				√	√		√		√			
runoff period	May-09																			
	Jun-09																			
	Jun-10																			
	Jun-11																			
	May-12																			
	May-13																			
	May-14																			
post-runoff period	Jul-09																			
	Aug-09																			
	Sep-09																			
	Nov-09																			
	Jul-10																			
	Sep-10																			
	Nov-10																			
	Jul-11																			
	Aug-11																			
	Sep-11																			
	Oct-11																			
	Oct-12																			
	Sep-14	√	√	√		√	√	√				√	√	√	√		√			√

[a] "upstream" location

prepared by: SJP (2/3/15)
reviewed by: EC (3/12/15)

Table 3.1
Surface water chronic benchmarks and sediment no effect and effect benchmarks
Baseline Ecological Risk Assessment
Upper Animas River Mining District

metals	surface water		sediment							
	chronic benchmarks (µg/L)		no effect benchmarks (mg/kg)				effect benchmarks (mg/kg)			
	CDPHE (2013)	Buchman (2008)	MacDonald *et al*. (2000)	Ingersoll *et al*. (1996)	Long *et al*. (1995)	Thompson *et al*., 2005	MacDonald *et al*. (2000)	Ingersoll *et al*. (1996)	Long *et al*. (1995)	Thompson *et al*., 2005
pH	6.5	--	--	--	--	--	--	--	--	--
Aluminum	87 or $e^{(1.3695[\ln(\text{hardness})]-0.1158)}$, depending on pH and hardness	87	--	26,000	--	--	--	60,000	--	--
Arsenic	150	190	9.8	11	8.2	9.3	33	48	70	56
Beryllium	NA	0.66	--	--	--	--	--	--	--	--
Cadmium	$(1.101672-[\ln(\text{hardness}) x(0.041838)] x e^{0.7998[\ln(\text{hardness})]-4.4451}$ (trout)	0.25	0.99	0.58	1.2	--	4.98	3.2	9.6	--
Chromium	$e^{(0.819[\ln(\text{hardness})]+0.5340)}$	74	43.4	36	81	36.7	111	120	370	69.2
Copper	$e^{(0.8545[\ln(\text{hardness})]-1.7428)}$	9	31.6	28	34	12	149	100	270	200
Iron	1,000	1,000	--	190,000	--	--	--	250,000	--	--
Lead	$(1.46203-[(\ln(\text{hardness}) x (0.145712)]) x e^{(1.273[\ln(\text{hardness})]-4.705)}$	3	35.8	37	46.7	27.7	128	82	218	380
Manganese	$e^{(0.3331[\ln(\text{hardness})]+5.8743)}$	80	--	630	--	--	--	1,200	--	--
Mercury	0.01	0.77	0.18	--	0.15	--	1.06	--	0.71	--
Nickel	$e^{(0.846[\ln(\text{hardness})]+0.0554)}$	52	22.7	20	20.9	21	48.6	33	51.6	170
Selenium	4.6	5.0 total	--	--	--	0.9	--	--	--	4.7
Silver	$e^{(1.72[\ln(\text{hardness})]-10.51)}$ (trout)	0.36	--	--	1.0	--	--	--	3.7	--
Zinc	$0.986 x e^{(0.9094[\ln(\text{hardness})]+0.6235)}$	120	121	98	150	--	459	540	410	--

shading identifies the benchmarks retained for use in the BERA

NA = not available

Sources:

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

Ingersoll, C.G. *etal*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. J. Great Lakes Res. 22:602-623.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (12/3/13)

reviewed by: EC (3/12/15)

Table 3.2
No effect and effect TRVs for birds
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte*	No effect TRVs		Effects TRVs	
	Eco-SSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Eco-SSL TRVs[c]	1996 toxicological benchmarks for wildlife[b]
Arsenic	2.24	5.1	4.51	12.8
Cadmium	1.47	1.45	6.35	20
Chromium III	2.66	1.0	15.6	5.0
Copper	4.05	47	34.9	61.7
Lead	1.63	1.13	44.6	11.3
Mercury (inorganic)	--	0.45	--	0.9
Nickel	6.71	77.4	18.6	107
Selenium	0.29	0.5	0.82	1.0
Silver	2.02	--	60.5	--
Zinc	66.1	14.5	171	131

* Only those analytes identified as "important bioaccumulatice compounds " in Table 4-2 of EPA (2000) are included in this table.

Footnotes:

All units are mg/kg bw-day

Shading identifies the TRVs selected for use in the BERA

[a] EPA Eco SSL reports (http://www.epa.gov/ecotox/ecossl), as follows:

EPA, 2005. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.
EPA, 2005. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.
EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.
EPA, 2007. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.
EPA, 2005. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.
EPA, 2007. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.
EPA, 2007. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.
EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.
EPA, 2007. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al.*, 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf(values are the toxicities measured in the test species)

[c] The effect TRVs were obtained from Table C-8 in Remedial Investigationreport for Lower Darby Creek Area Site, Clearview Landfill Operable Unit 1 (OU-1), Delaware and Philadelphia Counties, PA. May 2010. Prepared by TetraTech NUS, Inc. under EPA contract No. EP-S3-07-04.

-- not available

EcoSSL – ecological soil screening level

TRV – toxicity reference value

prepared by: SJP (12/4/13)
reviewed by: EC (3/12/15)

Table 3.3
No effect and effect TRVs for mammals
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte[*]	No effect TRVs		Effects TRVs	
	Eco-SSL TRVs[a]	1996 toxicological benchmarks for wildlife[b]	Eco-SSL TRVs[d]	1996 toxicological benchmarks for wildlife[b]
Arsenic	1.04	0.126	4.6	1.26
Cadmium	0.77	1.0	6.9	10.0
Chromium III	2.4	2737[e]	58.2	--
Copper	5.6	11.7	82.7	15.4
Lead	4.7	8.0	186.4	80
Mercury (inorganic)	--	1	--	3.0[c]
Nickel	1.7	40	14.8	80
Selenium	0.14	0.2	0.66	0.33
Silver	6.02	--	119	--
Zinc	75.4	160	298	320

[*] Only those analytes identified as "important bioaccumulatice compounds " in Table 4-2 of EPA (2000) are included in this attachment.

Footnotes:
All units are in mg/kg bw-day
Shading identifies TRVs selected for use in the SLERA
[a] USEPA Eco SSL reports (http://www.epa.gov/ecotox/ecossl),as follows:

EPA, 2005. Ecological soil screening levels for **arsenic**. Interim final. OSWER Directive 9285.7-62.
EPA, 2005. Ecological soil screening levels for **cadmium**. Interim final. OSWER Directive 9285.7-65.
EPA, 2008. Ecological soil screening levels for **chromium**. Interim final. OSWER Directive 9285.7-66.
EPA, 2007. Ecological soil screening levels for **copper**. Interim final. OSWER Directive 9285.7-68.
EPA, 2005. Ecological soil screening levels for **lead**. Interim final. OSWER Directive 9285.7-70.
EPA, 2007. Ecological soil screening levels for **nickel**. Interim final. OSWER Directive 9285.7-76.
EPA, 2007. Ecological soil screening levels for **selenium**. Interim final. OSWER Directive 9285.7-72.
EPA, 2006. Ecological soil screening levels for **silver**. Interim final. OSWER Directive 9285.7-77.
EPA, 2007. Ecological soil screening levels for **zinc**. Interim final. OSWER Directive 9285.7-73.

[b] Sample *et al*., 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, http://www.esd.ornl.gov/programs/ecorisk/documents/tm86r3.pdf(values are the toxicities measured in the test species)
[c] The reference did not provide an effect benchmark. The value represents the no effect benchmark X 3
[d] The effect TRVs were obtained from Table C-8 in Remedial Investigation report for Lower Darby Creek Area Site, Clearview Landfill Operable Unit 1 (OU-1), Delaware and Philadelphia Counties, PA. May 2010. Prepared by TetraTech NUS, Inc. under EPA contract No. EP-S3-07-04.
[e] The no effect TRV for CrIII is as reported in the reference
-- not available
EcoSSL – ecological soil screening level
TRV – toxicity reference value

prepared by: SJP (12/4/13)
reviewed by: EC (3/12/15)

Table 3.4
Selection of surface water COPECs for community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	24/24	4.97		7.30		M34	4.97	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	24/24	563		5950		M34	5950	87	--	--	1	**68.4**	**yes**	a
Arsenic	0/24	--		2.0	U	M34	2.0	150	--	--	1	<1	no	b
Beryllium	0/24	--		5.0	U	M34	5.0	0.66	--	--	2	**7.6**	**yes**	a
Cadmium	22/24	0.2		2.0		M34	2.0	--	150	0.58	1	**3.4**	**yes**	a
Chromium	0/24	--		2.5	U	M34	2.5	--	49	41	1	<1	no	b
Copper	12/24	1.5		16.2		M34	12.3	--	150	13.0	1	<1	no	a
Iron	24/24	754		8290		M34	8290	1,000	--	--	1	**8.3**	**yes**	a
Lead	6/24	0.1	J	4.2		M34	4.2	--	247	6.6	1	<1	no	b
Manganese	24/24	84.9		634		M34	592	--	238	2202	1	<1	no	b
Nickel	8/24	0.5	J	5.3		M34	2.0	--	49	28	1	<1	no	b
Selenium	0/24	--		1.3	U	M34	1.3	4.6	--	--	1	<1	no	b
Silver	2/24	0.5		0.6		M34	0.6	--	309	0.520	1	**1.2**	**yes**	a
Zinc	23/24	48.1		499		M34	499	--	150	175	1	**2.8**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in mainstem Mineral Creek.

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the detected analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.5
Selection of surface water COPECs for community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	25/25	3.24		5.40		CC48	3.24	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	25/25	1610		8610		CC48	8610	87	--	--	1	**99.0**	**yes**	a
Arsenic	0/25	--		2.0	U	CC48	2.0	150	--	--	1	<1	no	b
Beryllium	9/25	1.1		1.3		CC48	1.3	0.66	--	--	2	**2.0**	**yes**	a
Cadmium	25/25	2.0		7.00		CC48	5.1	--	67	0.31	1	**16.4**	**yes**	a
Chromium	0/25	--		5.0	U	CC48	2.5	--	67	53	1	<1	no	b
Copper	25/25	55.6		221		CC48	65.3	--	67	6.4	1	**10.3**	**yes**	a
Iron	25/25	3610		21700		CC48	21700	1000	--	--	1	**21.7**	**yes**	a
Lead	25/25	4.2		21.4		CC48	14.2	--	67	1.6	1	**8.9**	**yes**	a
Manganese	25/25	710		5300		CC49	5270	--	495	2810	1	**1.9**	**yes**	a
Nickel	22/25	2.2		19.4		CC48	5.9	--	67	37	1	<1	no	b
Selenium	1/25	3.2	J	3.2	J	CC48	3.2	4.6	--	--	1	<1	no	b
Silver	0/25	--		2.5	U	CC48	1.25	--	67	0.04	1	**31.3**	**yes**	a
Zinc	25/25	394		2890		CC48	1310	--	126	150	1	**8.7**	**yes**	a

Notes:

Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in mainstem Cement Creek.

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the detected analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in mainstem Cement Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.6
Selection of SW COPECs for community-level receptors in the Animas River above Mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect*	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	39/39	6.26		7.71		A68	6.26	6.50	--	--	1	<1[g]	no	b
Aluminum	35/40	101		1010		A68	1010	--	49	184	1	**5.5**	**yes**	a
Arsenic	0/40	--		2.0	U	multiple	2.0	150	--	--	1	<1	no	b
Beryllium	0/40	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	40/40	0.7		4.1		A68	4.1	--	148	0.57	1	**7.2**	**yes**	a
Chromium	0/40	--		2.5	U	A68	2.5	--	50	42	1	<1	no	b
Copper	24/40	2.7		16.5		A61	16.5	--	80	7.4	1	**2.2**	**yes**	a
Iron	31/40	111	J	1100		A68	1100	1000	--	--	1	**1.1**	**yes**	a
Lead	20/40	0.1	J	1.5		A66	1.5	--	64	1.5	1	**1.0**	**yes**	a
Manganese	40/40	153		3730		A68	3730	--	148	1880	1	**2.0**	**yes**	a
Nickel	0/40	--		2.0	U	A68	2.0	--	50	29	1	<1	no	b
Selenium	0/40	--		0.5	U	multiple	0.5	4.6	--	--	1	<1	no	b
Silver	0/40	--		0.25	U	multiple	0.25	--	49	0.02	1	**11.4**	**yes**	a
Zinc	40/40	237		1030		A68	1030		151	176	1	**5.8**	**yes**	a

Notes:
Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.
* For pH, the location shown is the one with the lowest-measured pH
** The pH benchmark is unitless
[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River above mainstem Cement Creek
[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration
[c] These benchmarks are not sensitive to surface water hardness
[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River above mainstem Cement Creek
[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)
[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark
[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:
a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark
b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:
1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.
2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.7
Selection of surface water COPECs for community-level receptors in the Animas River between mainstem Cement Creek and mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect[*]	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	2/2	5.54		6.05		A69A	5.54	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	2/2	2460	D	2520	D	A69A	2520	87	--	--	1	**29.0**	**yes**	a
Arsenic	0/2	--		0.25	U	multiple	0.25	150	--	--	1	<1	no	b
Beryllium	0/2	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	2/2	2.7		2.7		multiple	2.7	--	295	0.95	1	**2.8**	**yes**	a
Chromium	0/2	--		0.5	U	multiple	0.5	--	295	180	1	<1	no	b
Copper	2/2	16.3		24.8		A70B	24.8	--	295	23.0	1	**1.1**	**yes**	a
Iron	2/2	4890	D	5100	D	A69A	5100	1000	--	--	1	**5.1**	**yes**	a
Lead	2/2	0.2	J	3.0		A70B	3.0	--	295	8.0	1	<1	no	b
Manganese	2/2	2540		2590		A69A	2540	--	295	2365	1	**1.1**	**yes**	a
Nickel	2/2	4.8		5.2		A70B	5.2		295	130	1	<1	no	b
Selenium	0/2	--		0.25	U	multiple	0.25	4.6	--	--	1	<1	no	b
Silver	0/2	--		0.25	U	multiple	0.25	--	295	0.48	1	<1	no	b
Zinc	2/2	1160		1160		multiple	1160	--	295	324	1	**3.6**	**yes**	a

Notes:

Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

[*] For pH, the location shown is the one with the lowest-measured pH

[**] The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.8
Selection of surface water COPECs for community-level receptors in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Compound	Frequency of Detection	Minimum Detect (µg/L)	Flag	Maximum Detect (µg/L)[a]	Flag	Location of Maximum Detect*	Conc. used for Screening[b]	Benchmark (ug/L)[c,**]	Hardness (mg/L)[d]	Hardness-Adjusted Benchmark (ug/L)[e]	Bench-mark Source	Hazard Quotient[f]	COPEC?	Reason Code
pH	45/45	5.04		7.64		A72	5.04	6.50	--	--	1	**>1[g]**	**yes**	a
Aluminum	48/48	234	JD	4440		A72	4440	87	--	--	1	**51.0**	**yes**	a
Arsenic	0/48	--		2.0	U	multiple	2.0	150	--	--	1	<1	no	b
Beryllium	0/48	--		1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	48/48	0.3		2.9		A72	2.9	--	177	0.65	1	**4.5**	**yes**	a
Chromium	1/48	2.3		2.3		A72	2.3	--	261	163	1	<1	no	b
Copper	40/48	0.6	J	36.9		A72	36.9	--	296	23.0	1	**1.6**	**yes**	a
Iron	47/48	317		7710		A72	7710	1000	--	--	1	**7.7**	**yes**	a
Lead	16/48	0.1	J	2.7		A72	0.8	--	60	1.4	1	<1	no	b
Manganese	48/48	109		2920		A72	2920	--	337	2472	1	**1.2**	**yes**	a
Nickel	29/48	0.5	J	8.2		A72	1.4	--	37	22	1	<1	no	b
Selenium	0/48	--		1.25	U	multiple	1.30	4.6	--	--	1	<1	no	b
Silver	0/48	--		1.25	U	multiple	1.25		71	0.04	1	**31.3**	**yes**	a
Zinc	48/48	66.5		1230		A72	864	--	177	204	1	**4.2**	**yes**	a

Notes:

Dissolved analytical data were used for all metals except aluminum and iron where total metals data were used.

* For pH, the location shown is the one with the lowest-measured pH

** The pH benchmark is unitless

[a] These values represent the maximum detected concentrations, or half the maximum detection limit for a non-detected analyte (except for pH which represents the lowest reported value) measured between May 2009 and September 2014 in the Animas River below mainstem Mineral Creek

[b] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the maximum concentration

[c] These benchmarks are not sensitive to surface water hardness

[d] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between May 2009 and September 2014 in the Animas River below mainstem Mineral Creek

[e] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[f] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[g] pH values are logarithmic and cannot be used to calculate an HQ because the HQ approach assumes linearity

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34

prepared by: SJP (1/27/14) reviewed by: RI (2/10/14)
updated by: BB (2/17/15) reviewed by: EC (2/18/15)

Table 3.9
Summary of the surface water COPECs for community-level receptors
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek	Animas River above mainstem Cement Creek	Animas River between mainstem Cement and Mineral Creeks	Animas River below mainstem Mineral Creek
pH	√	√		√	√
Aluminum	√	√	√	√	√
Arsenic					
Beryllium	(√)	√	(√)	(√)	(√)
Cadmium	√	√	√	√	√
Chromium					
Copper		√	√	√	√
Iron	√	√	√	√	√
Lead		√	√		
Manganese		√	√	√	√
Nickel					
Selenium					
Silver	√	(√)	(√)		(√)
Zinc	√	√	√	√	√

(√) = analyte was not detected but was retained as a COPEC because 1/2 the max detection limit exceeded the benchmark

prepared by: SJP (1/31/14)
checked by: RI (2/10/14)
updated by: BB (2/17/15)
reviewed by: EC (2/18/15)

Table 3.10
Selection of sediment COPECS for the benthic invertebrate community in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Max Detect or 1/2 Max DL (mg/kg)	Flag	Location of Maximum	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	2 / 2	22,400	D	29,100	D	M34	29,100	26,000	2	**1.1**	**yes**	a
Arsenic	2 / 2	21.1	D	32.7	D	M34	32.7	9.8	1	**3.3**	**yes**	a
Beryllium	0 / 2	--		2.0	U	M34	2.0	NA	--	--	**yes**	c
Cadmium	2 / 2	0.9	D	1.9	D	M34	1.9	0.99	1	**1.9**	**yes**	a
Chromium	2 / 2	2.8	D	3.4	D	M34	3.4	43.4	1	<1	no	b
Copper	2 / 2	53.8	D	127	D	M34	127	31.6	1	**4.0**	**yes**	a
Iron	2 / 2	46,500	D	89,000	D	M34	89,000	190,000	2	<1	no	b
Lead	2 / 2	129	D	237	D	M34	237	35.8	1	**6.6**	**yes**	a
Manganese	2 / 2	1,160	D	1,430	D	M34	1,430	630	2	**2.3**	**yes**	a
Mercury	2 / 2	0.02	D	0.05	D	M34	0.05	0.18	1	<1	no	b
Nickel	2 / 2	4.6	D	5.9	BD	M34	5.9	22.7	1	<1	no	b
Selenium	1 / 2	1.7	D	1.7	D	M34	1.7	0.9	4	**1.9**	**yes**	a
Silver	2 / 2	0.7	D	0.9	JD	M34	0.9	1.0	3	<1	no	b
Zinc	2 / 2	270	D	666	D	M34	666	121	1	**5.5**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
D = sample was diluted before analysis
U = not detected

COPEC = contaminant of potential ecological concern
DL = detection limit

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *etal*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. J. Great Lakes Res. 22:602-623.

3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.11
Selection of sediment COPECS for the benthic invertebrate community in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Max Detect or 1/2 Max DL (mg/kg)	Flag	Location of Maximum	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	1 / 1	5310	D	5,310	D	CC49	5,310	26,000	2	<1	no	b
Arsenic	1 / 1	40.6	D	40.6	D	CC49	40.6	9.8	1	**4.1**	**yes**	a
Beryllium	0 / 1	--		1.0	U	CC49	1.0	NA	--	--	**yes**	c
Cadmium	1 / 1	0.6	D	0.6	D	CC49	0.6	0.99	1	<1	no	b
Chromium	1 / 1	4.6	D	4.6	D	CC49	4.6	43.4	1	<1	no	b
Copper	1 / 1	55.6	D	55.6	D	CC49	55.6	31.6	1	**1.8**	**yes**	a
Iron	1 / 1	143,000	D	143,000	D	CC49	143,000	190,000	2	<1	no	b
Lead	1 / 1	282	D	282	D	CC49	282	35.8	1	**7.9**	**yes**	a
Manganese	1 / 1	478	D	478	D	CC49	478	630	2	<1	no	b
Mercury	1 / 1	0.06	D	0.06	D	CC49	0.06	0.18	1	<1	no	b
Nickel	1 / 1	2.9	D	2.9	D	CC49	2.9	22.7	1	<1	no	b
Selenium	1 / 1	0.7	JD	0.7	JD	CC49	0.7	0.9	4	<1	no	b
Silver	1 / 1	2.0	D	2.0	D	CC49	2.0	1.0	3	**2.0**	**yes**	a
Zinc	1 / 1	195	D	195	D	CC49	195	121	1	**1.6**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
J = estimated concentration
D = sample was diluted before analysis
U = not detected

COPEC = contaminant of potential ecological concern
DL = detection limit

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available
DL = detection limit

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *et al*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalellaazteca* and the midge *Chironomus riparius*. J. Great Lakes Res. 22:602-623.

3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.12
Selection of sediment COPECs for the benthic invertebrate community in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Maximum Detect (mg/kg)	Flag	Location of Maximum Detect	Conc. used for Screening	Benchmark (mg/kg)	Bench-mark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	20 / 20	7650	D	15300	D	A68	15300	26000	2	<1	no	b
Arsenic	20 / 20	16.4	D	89.5	D	A68	89.5	9.8	1	**9.1**	**yes**	a
Beryllium	9 / 20	2.1	JD	6.8	D	A68	6.8	NA	--	--	**yes**	c
Cadmium	20 / 20	5.0	D	24.2	D	A68	24.2	0.99	1	**24.4**	**yes**	a
Chromium	20 / 20	3.6	D	6.4	D	A60	6.4	43.4	1	<1	no	b
Copper	20 / 20	166	D	745	D	A68	745	31.6	1	**23.6**	**yes**	a
Iron	20 / 20	22800	D	45300	D	A68	45300	190000	2	<1	no	b
Lead	20 / 20	554	D	3030	D	A68	3030	35.8	1	**84.6**	**yes**	a
Manganese	20 / 20	3400	D	22300	D	A68	22300	630	2	**35.4**	**yes**	a
Mercury	14 / 14	0.02	JD	0.19	D	A68	0.19	0.18	1	**1.1**	**yes**	a
Nickel	20 / 20	5.9	D	16.5	D	A68	16.5	22.7	1	<1	no	b
Selenium	4 / 20	0.91	JD	2.9	D	A68	2.9	0.9	4	**3.2**	**yes**	a
Silver	20 / 20	2.9	D	13.3	D	A68	13.3	1.0	3	**13.3**	**yes**	a
Zinc	20 / 20	1530	D	11500	D	A68	11500	121	1	**95.0**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
B = analyte was also detected in the blank
J = estimated concentration
D = sample was diluted before analysis

COPEC = contaminant of potential ecological concern

Reason codes:
a = the maximum concentration exceeds the sediment screening benchmark
b = the maximum concentration falls below the sediment screening benchmark
c = a benchmark is not available

Benchmark sources:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Ingersoll, C.G. *et al*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. J. Great Lakes Res. 22:602-623.

3. Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

4. Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and use of sediment guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.13
Selection of sediment COPECS for the benthic invertebrate community in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	Frequency of Detection	Minimum Detect (mg/kg)	Flag	Maximum Detect (mg/kg)[a]	Flag	Location of Maximum Detect	Concentration used for Screening	Benchmark (mg/kg)	Benchmark Source	Hazard Quotient[a]	COPEC?	Reason Code
Aluminum	23 / 23	6,620	D	48,600	D	A75B	48,600	26,000	2	**1.9**	**yes**	a
Arsenic	23 / 23	9.2	D	40.6	D	A72	40.6	9.8	1	**4.1**	**yes**	a
Beryllium	9 / 23	3.2	JD	6.0	D	A75B	6.0	--	--	NA	**yes**	c
Cadmium	23 / 23	1.2	D	18.6	D	Bbridge	18.6	0.99	1	**18.8**	**yes**	a
Chromium	23 / 23	2.8	D	7.4	BD	BBridge	7.4	43.4	1	< 1	no	b
Copper	23 / 23	67	D	413	D	A75B	413	31.6	1	**13.1**	**yes**	a
Iron	23 / 23	20,100	D	109,000	D	A73	109,000	190,000	2	< 1	no	b
Lead	23 / 23	98	D	729	D	A73	729	35.8	1	**20.4**	**yes**	a
Manganese	23 / 23	1,210	D	13,100	D	BBridge	13,100	630	2	**20.8**	**yes**	a
Mercury	15 / 17	0.02	JD	0.09	D	A73B	0.09	0.18	1	< 1	no	b
Nickel	23 / 23	4.33	D	31.6	D	BBridge	31.6	22.7	1	**1.4**	**yes**	a
Selenium	13 / 23	0.59	JD	3.3	D	A75B	3.3	0.9	4	**3.7**	**yes**	a
Silver	23 / 23	0.512	JD	3.1	D	A73B	3.1	1.0	3	**3.1**	**yes**	a
Zinc	23 / 23	386	D	8,670	D	BBridge	8,670	121	1	**71.7**	**yes**	a

[a] the hazard quotient is calculated by dividing a maximum concentration by its sediment screening benchmark
B = analyte was also detected in the blank
D = sample was diluted prior to analysis
J = estimated value

COPEC = contaminant of potential ecological concern

reason code:
a = the maximum detected concentration exceeds the screening benchmark
b = the maximum detected concentration does not exceed the screening benchmark
c = the analyte does not have a benchmark

Benchmark sources:
1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
2. Ingersoll, C.G. *et al*. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalellaazteca* and the midge *Chironomus riparius*. J, Great Lakes Res. 22:602-623.
3. Long, E.R, D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
activities in Canada. Environ. Monit. Assess. 110:71-85.

prepared by: SJP (12/27/13)
checked by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.14
Summary of the sediment COPECs for the benthic invertebrate community
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek	Animas River above mainstem Cement Creek	Animas River between mainstem Cement and Mineral Creeks[a]	Animas River below mainstem Mineral Creek
Aluminum	√				√
Arsenic	√	√	√		√
Beryllium	√	√	√		√
Cadmium	√		√		√
Chromium					
Copper	√	√	√		√
Iron					
Lead	√	√	√		√
Manganese	√		√		√
Mercury			√		
Nickel					√
Selenium	√		√		√
Silver		√	√		√
Zinc	√	√	√		√

[a] this reach of the Animas River was not sampled for sediment

prepared by: SJP (1/31/14)
checked by: RI (2/10/14)
revised by: BB (2/10/15)
reviewed by: ES (2/11/15)

Table 3.15
Selection of pore water COPECs for the benthic invertebrate community in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	8/11	21	J	6170	D	A61	6170	87[h]	--	--	1	**70.9**	**yes**	a
Arsenic	1/11	0.55	J	0.55	J	A60	0.55	150	--	--	1	<1	no	b
Beryllium	0/11	2.0	U	10.0	U	A61	10.0	0.66	--	--	2	**15.2**	**yes**	a
Cadmium	11/11	0.28		107	D	A61	107	--	497	1.42	1	**75.4**	**yes**	a
Chromium	2/11	0.8	J	1.8	J	A66	1.8	--	141	98	1	<1	no	b
Copper	11/11	1.3		2250	D	A61	2250	--	853	56.0	1	**40.2**	**yes**	a
Iron	0/11	100	U	500	U	A61	500	1000	--	--	1	<1	no	b
Lead	6/11	0.123	J	65.6	D	A61	65.6	--	497	13.6	1	**4.8**	**yes**	a
Manganese	10/11	2.6	J	78300	D	A61	78300	--	497	3369	1	**23.2**	**yes**	a
Nickel	4/11	11.3		77.5	D	A61	77.5	--	853	319	1	<1	no	b
Selenium	0/11	1.0	U	5.0	U	A61	5.0	4.6	--	--	1	**1.1**	**yes**	a
Silver	0/11	0.5	U	2.5	U	A61	0.25	--	118	0.10	1	**2.5**	**yes**	a
Zinc	11/11	179		29900	D	A61	18490	--	497	520	1	**35.6**	**yes**	a

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used to calculate the hazard quotients

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (2/24/15)
checked by: EC (2/26/15)

Table 3.16
Selection of pore water COPECs for the benthic invertebrate community in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	8/9	23	J	517		A72	517	87[h]	--	--	1	**5.9**	**yes**	a
Arsenic	1/9	3.7		3.7		BBridge	3.74	150	--	--	1	<1	no	b
Beryllium	0/9	2.0	U	1.0	U	multiple	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	7/9	0.33		3.0		A72	3.0	--	256	0.86	1	**3.5**	**yes**	a
Chromium	2/9	1.2	J	3.2		BBridge	3.2	--	271	168	1	<1	no	b
Copper	8/9	0.92	J	8.1		A72	8.1	--	256	20.0	1	<1	no	b
Iron	4/9	107	J	1260		BBridge	1260	1000	--	--	1	**1.3**	**yes**	**a**
Lead	3/9	0.19	J	0.45		A72	0.45	--	256	6.9	1	<1	no	b
Manganese	9/9	2.5	J	5870		BBridge	5870	--	271	2299	1	**2.6**	**yes**	a
Nickel	7/9	0.58	J	2.0		A72	2.0	--	256	115	1	<1	no	b
Selenium	0/9	1.0	U	0.5	U	multiple	0.5	4.6	--	--	1	<1	no	b
Silver	0/9	0.5	U	0.25	U	multiple	0.25	--	49	0.02	1	**12.5**	**yes**	a
Zinc	9/9	13.3	J	1630		A72	1630	--	256	285	1	**5.7**	**yes**	a

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used to calculate the hazard quotient

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (2/24/15)
checked by: EC (2/26/15)

Table 3.17
Selection of pore water COPECs for the benthic invertebrate community in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Compound	Frequency of Detection	Minimum Detect (µg/L)[a]	Flag	Maximum Detect (µg/L)[b]	Flag	Location of Maximum Detect	Conc. used for Screening[c]	Benchmark (ug/L)[d]	Hardness (mg/L)[e]	Hardness-Adjusted Benchmark (ug/L)[f]	Bench-mark Source	Hazard Quotient[g]	COPEC?	Reason Code
Aluminum	1/1	45.7	J	45.7	J	M34	45.7	87[h]	--	--	1	<1	no	b
Arsenic	0/1	0.5	U	0.25	U	M34	0.25	150	--	--	1	<1	no	b
Beryllium	0/1	2.0	U	1.0	U	M34	1.0	0.66	--	--	2	**1.5**	**yes**	a
Cadmium	1/1	0.13	J	0.13	J	M34	0.13	--	139	0.54	1	<1	no	b
Chromium	0/1	1.0	U	0.5	U	M34	0.5	--	139	97	1	<1	no	b
Copper	1/1	1.2		1.2		M34	1.2	--	139	12	1	<1	no	b
Iron	0/1	100	U	50	U	M34	50	1000	--	--	1	<1	no	b
Lead	0/1	0.1	U	0.05	U	M34	0.05	--	139	3.6	1	<1	no	b
Manganese	1/1	27.6		27.6		M34	27.6	--	139	1841	1	<1	no	b
Nickel	0/1	0.5	U	0.25	U	M34	0.25	--	139	69	1	<1	no	b
Selenium	0/1	1.0	U	0.5	U	M34	0.5	4.6	--	--	1	<1	no	b
Silver	0/1	0.5	U	0.25	U	M34	0.25	--	139	0.10	1	**2.5**	**yes**	a
Zinc	1/1	48.2		48.2		M34	48.2	--	139	163	1	<1	no	b

[a] These values represent the minimum detected dissolved metals concentrations, or the minimum detection limit for a non-detected analyte, measured in April and September 2014 in pore water samples collected from the Animas River upstream from mainstem Cement Creek

[b] These values represent the maximum detected dissolved metals concentrations, or half the maximum detection limit for a non-detected analyte, measured in April and September 2014 in the Animas River upstream from mainstem Cement Creek

[c] For hardness-dependent metals, the concentration used for screening may differ from the maximum concentration if hardness caused another concentration to yield a higher hazard quotient than the one associated with the maximum concentration

[d] These benchmarks are not sensitive to surface water hardness

[e] This hardness was associated with the analyte concentration that resulted in the highest HQ measured between in April or September 2014 in the Animas River between mainstem Cement Creek and mainstem Mineral Creek

[f] The formulae used to adjust the benchmarks for hardness were obtained from CDPHE, 2013 (see "benchmark sources" below)

[g] the hazard quotient is calculated by dividing a screening concentration by its benchmark

[h] CDPHE developed a benchmark equation for Al based on total Al, hardness, and pH. The latter parameter was not available. Instead, EPA's National Recommneded Water Quality Criterion of 87 µg/L was used in the calculations

Reason codes:

a = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, exceeds its chronic surface water benchmark

b = the maximum concentration, or 1/2 the maximum detection limit for a non-detected analyte, falls below the chronic surface water benchmark

Benchmark sources:

1 = Colorado Department of Public Health and the Environment (CDPHE), 2013. Regulation no. 31 – The basic standards and methodologies for surface water (5 CCR 1002 – 31): Denver, Water Quality Control Commission.

2 = Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pp

prepared by: SJP (2/24/15)

checked by: EC (2/26/15)

Table 3.18
Summary of the pore water COPECs for the benthic invertebrate community
Baseline Ecological Risk Assessment
Upper Animas River District

Analyte	mainstem Mineral Creek	mainstem Cement Creek[a]	Animas River above mainstem Cement Creek	Animas R. between Cement and Mineral Creeks[a]	Animas River below mainstem Mineral Creek
Aluminum			√		√
Arsenic					
Beryllium	(√)		(√)		(√)
Cadmium			√		√
Chromium					
Copper			√		
Iron					√
Lead			√		
Manganese			√		√
Mercury					
Nickel					
Selenium			(√)		
Silver	(√)		(√)		(√)
Zinc			√		√

[a] this reach was not sampled for pore water

(√) = analyte was not detected but was retained as a COPEC because 1/2 the max detection limit exceeded the benchmark

prepared by: SJP (2/26/15)

checked by: EC (2/26/15)

Table 3.19
October 2012 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A56 ("upstream")	none	100%	100%	NS
A68	none	100%	100%	NS
A72	none	100%	0%	S
A73B	none	100%	100%	NS
A75B	none	100%	100%	NS
Bakers Bridge	none	100%	100%	NS
Serial dilution #1 acute toxicity test results				
M34/CC48	A56	6.25%	100%	NS
M34/CC48	A56	12.5%	100%	NS
M34/CC48	A56	25%	100%	NS
M34/CC48	A56	50%	97.5%	NS
M34/CC48	A56	100%	0%	S
Serial dilution #2 acute toxicity test results				
M34/CC48	A68	6.25%	100%	NS
M34/CC48	A68	12.5%	100%	NS
M34/CC48	A68	25%	100%	NS
M34/CC48	A68	50%	37.5%	S

S = significant; NS = non significant

Statistical significance was tested against the laboratory control water sample

Table 3.20
November 2012 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A68	none	100%	92.5%	NS
M34	none	100%	0%	S
Serial dilution #1 acute toxicity test results				
A72	A68	5%	92.5%	NS
A72	A68	10%	94.7%	NS
A72	A68	25%	92.2%	NS
A72	A68	50%	100%	NS
A72	A68	75%	100%	NS
A72	A68	100%	2.5%	S
Serial dilution #2 acute toxicity test results				
CC48	A68	1%	85%	NS
CC48	A68	3%	97.5%	NS
CC48	A68	6%	97.5%	NS
CC48	A68	12%	90%	NS
CC48	A68	25%	90%	NS
CC48	A68	50%	0%	S
Serial dilution #3 acute toxicity test results				
M34/CC48	A68	4%	97.5%	NS
M34/CC48	A68	9%	95%	NS
M34/CC48	A68	20%	100%	NS
M34/CC48	A68	40%	92.5%	NS
M34/CC48	A68	65%	0%	S
M34/CC48	A68	85%	0%	S

S = significant; NS = non significant
The statistical significance of the three serial dilution results was tested against the laboratory control water sample, whereas the statistical significance of survival in samples A68 and M34 was determined using a *t*-test

prepared by: SJP (1/6/14)
reviewed by:

Table 3.21
April 2013 acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Diluent	Sample Strength	Survival	Signif.?
Site-specific acute toxicity test results				
A68	none	100%	67.5%	S
A72	none	100%	0%	S
A73	none	100%	98%	NS
A73B	none	100%	97.5%	NS
A75B	none	100%	100%	NS
M34	none	100%	15%	S
Serial dilution #1 acute toxicity test results				
A72	HRW	12%	100%	NS
A72	HRW	25%	100%	NS
A72	HRW	35%	100%	NS
A72	HRW	50%	100%	NS
A72	HRW	75%	100%	NS
A72	HRW	88%	97.5%	NS
Serial dilution #2 acute toxicity test results				
CC48/M34	A68	25%	100%	NS
CC48/M34	A68	50%	90%	NS
CC48/M34	A68	75%	0%	S
CC48/M34	A68	80%	0%	S
CC48/M34	A68	90%	0%	S
CC48/M34	A68	95%	0%	S
Serial dilution #3 acute toxicity test results				
CC48/M34	HRW	25%	100%	NS
CC48/M34	HRW	50%	100%	NS
CC48/M34	HRW	75%	100%	NS
CC48/M34	HRW	90%	0%	S
CC48/M34	HRW	95%	0%	S

HRW = hard reconstituted water

S = significant; NS = non significant

Statistical significance was tested against the laboratory control water sample

Table 3.22
Summary of the acute surface water toxicity test results for juvenile rainbow trout
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Sampling Timeframe					
	Oct. 2012	signif.?	Nov. 2012	signif.?	April 2013	signif.?
Animas River						
A56 ("upstream")	100%	NS	nt	--	nt	--
A68	100%	NS	92.5%	NS	67.5%	S
A72	0%	S	2.5%	S	0%	S
A73	nt	--	nt	--	98%	NS
A73B	100%	NS	nt	--	97.5%	NS
A75B	100%	NS	nt	--	100%	NS
Bakers Bridge	100%	NS	nt	--	nt	--
Mineral Creek						
M34	nt	--	0%	S	15%	S
Cement Creek						
CC48	nt	--	0%	S	nt	--

value shown is survival
nt = not tested
S = significant; NS = non significant

prepared by: SJP (1/29/14)
reviewed by:

Table 3.23
Toxicity in the amphipod *H. azteca* exposed to sediment in the laboratory
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample ID	Dec. 2012 test		Nov. 2014 test		Dec. 2012 test		Nov. 2014 test	
	Survival (mean±SE)	Signif?[a]	Survival (mean±SE)	Signif?[a]	Biomass[b] (mean±SE)	Signif?[a]	Biomass[b] (mean±SE)	Signif?[a]
Laboratory control sample								
Lab	97.5±1.6%	--	92.5±3.1%	--	69.8±3.5 µg/org	--	78.1±4.2 µg/org	--
Animas River "upstream"								
A56	62.5±8.2%	Y	43.8±9.2%	Y	20.3±1.9 µg/org	Y	14.3±3.2 µg/org	Y
Animas River above main stem Cement Creek								
A60	not tested	--	77.5±6.5%	N	not tested	--	23.1±1.9 µg/org	Y
A68	56.3±3.2%	Y	70.0±10.0%	N	22.6±1.6 µg/org	Y	23.2±3.3 µg/org	Y
Mainstem Cement Creek								
CC49	0%	Y	not tested	--	no survival	--	not tested	--
Mainstem Mineral Creek								
M34	8.8±3.5%	Y	not tested	--	5.1±2.0 µg/org	Y	not tested	--
Animas River below mainstem Mineral Creek								
A72	36.3±4.2%	Y	70.0±4.6%	N	16.1±1.7 µg/org	Y	27.9±2.4 µg/org	Y
A73	not tested	--	73.8±7.8%	N	not tested	--	21.2±2.4 µg/org	Y
A73B	5.0±1.9%	Y	not tested	--	4.0±1.7 µg/org	Y	not tested	--
A75D	not tested	--	76.3±7.5%	N	not tested	--	24.9±3.2 µg/org	Y
A75B	48.8±5.2%	Y	not tested	--	17.8±1.9 µg/org	Y	not tested	--
Bbridge	76.3±3.8%	Y	86.3±3.8%	N	26.2±1.0 µg/org	Y	30.7±2.2 µg/org	Y

SE = standard error
[a] is the response statistically significant from that observed in the test-specific laboratory control sample?
[b] biomass = total dry weight of surviving organisms on day 10/number of organisms originally introduced on day 0

prepared by: SJP (2/24/15)
reviewed by: EC (2/25/15)

Table 3.24
Summary of select benthic invertebrate community data from the Animas River, mainstem Cement Creek, and mainstem Mineral Creek (Sep. 2014)
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	total # of taxa	# of EPT taxa	# of intolerant taxa	H'	HBI	EPT Index[a]	Ephemerata Abundance[c]	%EPT[b]	Tolerant Organisms[d]	Filterers[d]	Scrapers[d]	Clingers[d]
Animas River above mains stem Cement Creek												
A56 ("upstream")	18	13	12	2.24	4.28	72.2%	10.8%	37.8%	1.3%	73.0%	8.3%	90.8%
A60	25	14	16	3.21	3.67	56.0%	11.3%	39.1%	3.4%	44.9%	12.3%	64.8%
A68	17	10	9	2.83	4.19	58.8%	15.5%	32.6%	2.7%	38.7%	11.9%	48.8%
Animas River below main stem Mineral Creek												
A72	9	4	3	2.19	1.87	44.4%	3.4%	54.3%	2.6%	38.8%	0.9%	53.4%
A73	11	7	8	1.61	1.28	63.6%	3.9%	96.1%	0.0%	71.3%	7.8%	92.2%
A75D	21	9	12	3.27	2.46	42.9%	24.8%	64.4%	15.8%	32.7%	15.8%	61.4%
Bakers Bridge	17	8	8	2.33	3.94	47.1%	52.9%	77.1%	2.7%	37.7%	1.3%	39.9%
main stem Cement Creek												
CC49	2	0	0	0.72	8.00	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%
main stem Mineral Creek												
M34	12	7	6	2.1	1.66	58.3%	3.9%	86.3%	3.9%	62.7%	3.9%	86.3%

source: Appendix G (Macroinvertebrate assemblage results report), TechLaw. 2014. Sampling Activities Report. 2014. 2014 Sampling Events. Upper Animas Mining District. Gladstone, San Juan County, CO. Draft report prepared for US EPA Region 8, Ecosystem Protection and Remediation - Program Support.
H' = Shannon Weaver Diversity
HBI = Hilsendorf Biotic Index
EPT = Ephemeroptera, Plecoptera, Trichoptera
[a] % of total number of taxa
[b] % of total number of organisms consisiting of EPT
[c] Ephemoptera abundance = % of total number
[d] % of total number of organisms

prepared by: SJP (2/13/15)
reviewed by:

Table 4.1
Surface water EPCs for community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	4,575	5,950	6,544	95% Student's-t UCL	5,950	4,575
Cadmium (dissolved)	4 / 4	1.3	2.0	1.852	95% Student's-t UCL	1.9	1.3
Iron (total)	4 / 4	5,868	6,830	7,240	95% Student's-t UCL	6,830	5,868
Silver (dissolved)	2 / 4	0.4	0.6	NA	NA	0.6	0.4
Zinc (dissolved)	4 / 4	358	499	470	95% Student's-t UCL	470	358
RUNOFF PERIOD							
Aluminum (total)	7 / 7	1353	2610	1910	95% Student's-t UCL	1,910	1,353
Cadmium (dissolved)	5 / 7	0.3	0.6	0.403	95% KM (t) UCL	0.4	0.3
Iron (total)	7 / 7	2,664	6,330	4,119	95% Student's-t UCL	4,119	2,664
Silver (dissolved)	0 / 7	0.4	1.3 U	NA	NA	1.3	0.4
Zinc (dissolved)	6 / 7	83.9	146	104.4	95% KM (t) UCL	104	83.9
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 13	2,267	4,590	2,826	95% Student's-t UCL	2,826	2,267
Cadmium (dissolved)	13 / 13	0.61	1.0	0.724	95% Student's-t UCL	0.7	0.6
Iron (total)	13 / 13	3,339	8,290	4,316	95% Student's-t UCL	4,316	3,339
Silver (dissolved)	0 / 13	0.3	1.3 U	NA	NA	1.3	0.3
Zinc (dissolved)	13 / 13	160	317	194	95% Student's-t UCL	194	160

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.2
Surface water EPCs for community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs RME	Surface Water EPCs CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	7,318	8,610	9,192	95% Student's-t UCL	8,610	7,318
Beryllium (dissolved)	3 / 4	1.2	1.3	1.311	95% KM (t) UCL	1.3	1.2
Cadmium (dissolved)	4 / 4	5.3	5.5	5.546	95% Student's-t UCL	5.5	5.3
Copper (dissolved)	4 / 4	107	119	122	95% Student's-t UCL	119	107
Iron (total)	4 / 4	17,150	21,700	22,006	95% Student's-t UCL	21,700	17,150
Lead (dissolved)	4 / 4	14.2	15.1	15.1	95% Student's-t UCL	15.1	14.2
Manganese (dissolved)	4 / 4	4,618	5,290	5,867	95% Student's-t UCL	5,290	4,618
Zinc (dissolved)	4 / 4	2,303	2,670	2,878	95% Student's-t UCL	2,670	2,303
RUNOFF PERIOD							
Aluminum (total)	7 / 7	2,389	3,280	2,876	95% Student's-t UCL	2,876	2,389
Beryllium (dissolved)	0 / 7	0.7	1.0 U	NA	NA	1.0	0.7
Cadmium (dissolved)	7 / 7	2.8	3.8	3.3	95% Student's-t UCL	3.3	2.8
Copper (dissolved)	7 / 7	68.6	90.6	78.1	95% Student's-t UCL	78.1	68.6
Iron (total)	7 / 7	8,067	17,200	12,554	95% Student's-t UCL	12,554	8,067
Lead (dissolved)	7 / 7	8.4	13.1	10.4	95% Student's-t UCL	10.4	8.4
Manganese (dissolved)	7 / 7	1,268	1,770	1,620	95% Student's-t UCL	1,620	1,268
Zinc (dissolved)	7 / 7	929.3	1,310	1,144	95% Student's-t UCL	1,144	929
POST-RUNOFF PERIOD							
Aluminum (total)	14 / 14	6,360	7,930	7,110	95% Student's-t UCL	7,110	6,360
Beryllium (dissolved)	6 / 14	1.1	1.2	1.0	95% KM(t) UCL	1.0	1.1
Cadmium (dissolved)	14 / 14	5.6	7.0	6.1	95% Student's-t UCL	6.1	5.6
Copper (dissolved)	14 / 14	130	221	152	95% Student's-t UCL	152	130
Iron (total)	14 / 14	10,801	18,600	12,725	95% Student's-t UCL	12,725	10,801
Lead (dissolved)	14 / 14	15.5	21.4	17.1	95% Student's-t UCL	17.1	15.5
Manganese (dissolved)	14 / 14	4,112	5,300	5,801	95% Chebyshev (Mean, Sd) UCL	5,300	4,112
Zinc (dissolved)	14 / 14	2,190	2,890	3,033	95% Chebyshev (Mean, Sd) UCL	2,890	2,190

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.3
Surface water EPCs for community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect or 1/2 max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs RME	Surface Water EPCs CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	5 / 5	305	438	401	95% Student's-t UCL	401	305
Cadmium (dissolved)	5 / 5	2.6	4.1	3.6	95% Student's-t UCL	3.6	2.6
Copper (dissolved)	2 / 5	7.2	8.3	8.435	95% KM (t) UCL	8.3	7.2
Iron (total)	5 / 5	259	334	309.3	95% Student's-t UCL	309	259
Lead (dissolved)	0 / 5	0.4	0.5 U	NA	NA	0.5	0.4
Manganese (dissolved)	5 / 5	3,300	3,730	3,676	95% Student's-t UCL	3,676	3,300
Zinc (dissolved)	5 / 5	840	1,030	1,012	95% Student's-t UCL	1,012	840
RUNOFF PERIOD							
Aluminum (total)	17 / 17	480	1,010	566	95% Student's-t UCL	566	480
Cadmium (dissolved)	17 / 17	1.04	1.5	1.15	95% Modified-t UCL	1.1	1.0
Copper (dissolved)	15 / 17	10.0	16.5	11.3	95% KM (t) UCL	11.3	10.0
Iron (total)	16 / 17	469	1,100	556	95% KM(t) UCL	556	469
Lead (dissolved)	13 / 17	1.0	1.5	1.08	95% KM(t) UCL	1.1	1.0
Manganese (dissolved)	17 / 17	514	1,220	633	95% Student's-t UCL	633	514
Zinc (dissolved)	17 / 17	344.2	509	381	95% Modified-t UCL	381	344
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 18	153	217	154	95% KM (t) UCL	154	153
Cadmium (dissolved)	18 / 18	1.1	1.7	1.2	95% Student's-t UCL	1.2	1.1
Copper (dissolved)	7 / 18	3.17	3.5	3.223	95% KM (Percentile Bootstrap) UCL	3.2	3.2
Iron (total)	10 / 18	154	234	149	95% KM (Percentile Bootstrap) UCL	149	154
Lead (dissolved)	7 / 18	0.308	0.4	0.339	95% KM (Percentile Bootstrap) UCL	0.3	0.3
Manganese (dissolved)	18 / 18	1,031	2,380	1,247	95% Student's-t UCL	1,247	1,031
Zinc (dissolved)	18 / 18	327	567	362	95% Student's-t UCL	362	327

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.4
Surface water EPCs for community-level receptors in the Animas River between mainstem Cement Creek and mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	2 / 2	2,490	2,520	NA	NA	2,520	2,490
Cadmium (dissolved)	2 / 2	2.7	2.7	NA	NA	2.7	2.7
Copper (dissolved)	2 / 2	20.6	24.8	NA	NA	24.8	20.6
Iron (total)	2 / 2	4,995	5,100	NA	NA	5,100	4,995
Manganese (dissolved)	2 / 2	2,565	2,590	NA	NA	2,590	2,565
Zinc (dissolved)	2 / 2	1,160	1,160	NA	NA	1,160	1,160

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.5
Surface water EPCs for community-level receptors at sampling location A71B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	1 / 1	2,780	2,780	NA	NA	2,780	2,780
Cadmium (dissolved)	1 / 1	1.9	1.9	NA	NA	1.9	1.9
Copper (dissolved)	1 / 1	8.7	8.7	NA	NA	8.7	8.7
Iron (total)	1 / 1	4,640	4,640	NA	NA	4,640	4,640
Manganese (dissolved)	1 / 1	1,660	1,660	NA	NA	1,660	1,660
Zinc (dissolved)	1 / 1	743	743	NA	NA	743	743

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.6
Surface water EPCs for community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Max Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs RME	CTE
PRE-RUNOFF PERIOD							
Aluminum (total)	4 / 4	3,455	4,440	4,739	95% Student's-t UCL	4,440	3,455
Cadmium (dissolved)	4 / 4	2.7	2.9	2.9	95% Student's-t UCL	2.9	2.7
Copper (dissolved)	4 / 4	28.9	35.9	38	95% Student's-t UCL	35.9	28.9
Iron (total)	4 / 4	6,018	7,710	7,967	95% Student's-t UCL	7,710	6,018
Manganese (dissolved)	4 / 4	2,435	2,920	3,028	95% Student's-t UCL	2,920	2,435
Zinc (dissolved)	4 / 4	1,044	1,230	1,232	95% Student's-t UCL	1,230	1,044
RUNOFF PERIOD							
Aluminum (total)	7 / 7	1,359	3,060	2,065	95% Student's-t UCL	2,065	1,359
Cadmium (dissolved)	7 / 7	0.9	1.4	1.0	95% Student's-t UCL	1.0	0.9
Copper (dissolved)	5 / 7	5.2	7.6	6.7	95% KM(t) UCL	6.7	5.2
Iron (total)	7 / 7	2,905	7,200	4,687	95% Student's-t UCL	4,687	2,905
Manganese (dissolved)	7 / 7	427	823	578	95% Student's-t UCL	578	427
Zinc (dissolved)	7 / 7	273	453	352	95% Student's-t UCL	352	273
POST-RUNOFF PERIOD							
Aluminum (total)	13 / 13	1,777	2,750	2,129	95% Student's-t UCL	2,129	1,777
Cadmium (dissolved)	13 / 13	1.6	2.8	1.9	95% Student's-t UCL	1.9	1.6
Copper (dissolved)	8 / 13	14.2	36.9	17.3	95% KM(t) UCL	17.3	14.2
Iron (total)	13 / 13	2,701	5,490	3,409	95% Student's-t UCL	3,409	2,701
Manganese (dissolved)	13 / 13	1,242	2,490	1,514	95% Student's-t UCL	1,514	1,242
Zinc (dissolved)	13 / 13	579	1,120	696	95% Student's-t UCL	696	579

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.7
Surface water EPCs for community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	1,461	2,420	2,030	95% Student's-t UCL	2,030	1,461
Cadmium (dissolved)	5 / 5	1.3	1.8	1.704	95% Student's-t UCL	1.7	1.3
Copper (dissolved)	5 / 5	3.7	5.0	5.082	95% Student's-t UCL	5.0	3.7
Iron (total)	5 / 5	2,986	4,210	4,163	95% Student's-t UCL	4,163	2,986
Manganese (dissolved)	5 / 5	1,009	1,830	1,592	95% Student's-t UCL	1,592	1,009
Zinc	5 / 5	463	701	666	95% Student's-t UCL	666	463

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.8
Surface water EPCs for community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs RME	Surface Water EPCs CTE
Aluminum (total)	4 / 4	975	1,980	1,764	95% Students (t) UCL	1,764	975
Cadmium (dissolved)	4 / 4	0.7	1.4	1.271	95% Students (t) UCL	1.3	0.7
Copper (dissolved)	4 / 4	2.6	3.8	3.844	95% Students (t) UCL	3.8	2.6
Iron (total)	4 / 4	1,570	2,790	2,649	95% Students (t) UCL	2,649	1,570
Manganese (dissolved)	4 / 4	508	1,210	1,079	95% Students (t) UCL	1,079	508
Zinc (dissolved)	4 / 4	250	561	500.1	95% Students (t) UCL	500	250

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.9
Surface water EPCs for community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	1,255	1,790	1,728	95% Student's-t UCL	1,728	1,255
Cadmium (dissolved)	5 / 5	0.8	1.1	1.036	95% Student's-t UCL	1.0	0.8
Copper (dissolved)	5 / 5	2.5	4.2	3.887	95% Student's-t UCL	3.9	2.5
Iron (total)	5 / 5	2,556	4,610	3,922	95% Student's-t UCL	3,922	2,556
Manganese (dissolved)	5 / 5	590	1,090	935.1	95% Student's-t UCL	935	590
Zinc	5 / 5	261	427	384.2	95% Student's-t UCL	384	261

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.10
Surface water EPCs for community-level receptors at sampling location A75B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	4 / 4	1,021	1,650	1,565	95% Student's-t UCL	1,565	1,021
Cadmium (dissolved)	4 / 4	0.7	1.1	1.031	95% Student's-t UCL	1.0	0.7
Copper (dissolved)	4 / 4	2.6	4.1	4.476	95% Student's-t UCL	4.1	2.6
Iron (total)	4 / 4	2,224	4,810	4,454	95% Student's-t UCL	4,454	2,224
Manganese (dissolved)	4 / 4	462	856	781.7	95% Student's-t UCL	782	462
Zinc	4 / 4	235	442	401.5	95% Student's-t UCL	402	235

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.11
Surface water EPCs for community-level receptors at sampling location Bakers Bridge in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (total)	5 / 5	704	1,310	1103	95% Student's-t UCL	1,103	704
Cadmium (dissolved)	5 / 5	0.5	0.7	0.613	95% Student's-t UCL	0.6	0.5
Copper (dissolved)	4 / 5	2.9	3.7	3.701	95% KM (t) UCL	3.7	2.9
Iron (total)	4 / 5	1,717	3,560	2,742	95% KM (t) UCL	2,742	1,717
Manganese (dissolved)	5 / 5	356	584	542.5	95% Student's-t UCL	543	356
Zinc	5 / 5	136	241	203.9	95% Student's-t UCL	204	136

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.12
Sediment EPCs for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
							RME	CTE
Metals (mg/kg)								
Arsenic	2 / 2	26.9	32.7 D	--	NA	NA	32.7	26.9
Copper	2 / 2	90.4	127 D	--	NA	NA	127	90.4
Lead	2 / 2	183	237 D	--	NA	NA	237	183
Manganese	2 / 2	1,295	1,430 D	--	NA	NA	1,430	1,295
Selenium	1 / 2	1.7	1.7 D	--	NA	NA	1.7	1.7
Zinc	2 / 2	468	666 D	--	NA	NA	666	468

mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.13
Sediment EPCs for mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
							RME	CTE
Metals (mg/kg)								
Arsenic	1 / 1	40.6	40.6 D	--	NA	NA	40.6	40.6
Copper	1 / 1	55.6	55.6 D	--	NA	NA	55.6	55.6
Lead	1 / 1	282	282 D		NA	NA	282	282
Silver	1 / 1	2.0	2.0 D	--	NA	NA	2.0	2.0
Zinc	1 / 1	195	195 D	--	NA	NA	195	195

mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration

prepared by: SJP (2/2/14)
reviewed by: RI (2/10/14)
updated by: EC (2/24/15)
reviewed by: BB (2/26/15)

Table 4.14
Sediment EPCs for the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Arsenic [a]	yes	yes	20 / 20	27.4	89.5 D	--	34.24	95% Modified-tUCL	34.2	27.4
Cadmium[a]	yes	yes	20 / 20	11.1	24.2 D	--	12.91	95% Student's-t UCL	12.9	11.1
Chromium[a]	no	yes	20 / 20	4.7	6.4 D	--	4.971	95% Student's-t UCL	5.0	4.7
Copper[a]	yes	yes	20 / 20	339	745 D	--	399.3	95% Adjusted Gamma UCL	399	339
Lead[a]	yes	yes	20 / 20	1,508	3,030 D	--	1,733	95% Student's-t UCL	1,733	1,508
Manganese	yes	no	20 / 20	10,617	22,300 D	--	12,566	95% Student's-t UCL	12,566	10,617
Mercury[a]	yes	yes	14 / 14	0.07	0.19 D	--	0.0914	95% Student's-t UCL	0.1	0.07
Nickel[a]	no	yes	20 / 20	8.2	16.5 D	--	9.2	95% Modified-t UCL	9.2	8.2
Selenium [a]	yes	yes	4 / 20	1.54	2.9 D	--	0.998	95%KM (t) UCL	0.998	1.5
Silver[a]	yes	yes	20 / 20	5.5	13.3 D	--	6.43	95% Student's-t UCL	6.4	5.5
Zinc [a]	yes	yes	20 / 20	3,172	11,500 D	--	4,054	95% Modified-t UCL	4,054	3,172

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
NC = not calculated because of small sample size.
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.15
Sediment EPCs at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Aluminum	yes	no	5 / 5	14,872	21,500 D	--	19,659	95% Student's-tUCL	19,659	14,872
Arsenic[a]	yes	yes	5 / 5	33.4	40.6 D	--	39.58	95% Student's-tUCL	39.6	33.4
Cadmium[a]	yes	yes	5 / 5	2.1	3.03 D	--	2.852	95% Student's-tUCL	2.9	2.1
Chromium[a]	no	yes	5 / 5	4.6	6.41 BD	--	6.087	95% Student's-tUCL	6.1	4.6
Copper[a]	yes	yes	5 / 5	137	179 D	--	172.9	95% Student's-tUCL	173	137
Lead[a]	yes	yes	5 / 5	478	581 D	--	581.8	95% Student's-tUCL	581	478
Manganese	yes	no	5 / 5	2,100	3,400 D	--	2979	95% Student's-tUCL	2,979	2,100
Mercury[a]	no	yes	4 / 4	0.055	0.072 D	--	0.072	95% Student's-tUCL	0.07	0.06
Nickel[a]	yes	yes	5 / 5	5.1	6.4 D	--	5.884	95% Student's-tUCL	5.9	5.1
Selenium[a]	yes	yes	4 / 5	1.5	2.0 D	--	1.881	95% KM (t) UCL	1.9	1.5
Silver[a]	yes	yes	5 / 5	1.9	2.8 D	--	2.425	95% Student's-tUCL	2.4	1.9
Zinc[a]	yes	yes	5 / 5	650.8	858 D	--	818.5	95% Student's-tUCL	819	651

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.16
Sediment EPCs at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analytes	COPEC? benthos	COPEC? wildlife	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs RME	Sediment EPCs CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	17,123	40,700 D	--	35,775	95% Student's-tUCL	35,775	17,123
Arsenic[a]	yes	yes	4 / 4	27.9	33.8 D	--	35.09	95% Student's-tUCL	33.8	27.9
Cadmium[a]	yes	yes	4 / 4	4.0	5.6 D	--	5.433	95% Student's-tUCL	5.4	4.0
Chromium[a]	no	yes	4 / 4	4.0	5.6 BD	--	5.376	95% Student's-tUCL	5.4	4.0
Copper[a]	yes	yes	4 / 4	199	284 D	--	284.2	95% Student's-tUCL	284	199
Lead[a]	yes	yes	4 / 4	513	729 D	--	733.6	95% Student's-tUCL	729	513
Manganese	yes	no	4 / 4	4,340	7,120 D	--	6,618	95% Student's-tUCL	6,618	4,340
Mercury[a]	no	yes	3 / 3	0.04	0.05 D	--	0.0606	95% Student's-tUCL	0.05	0.04
Nickel[a]	yes	yes	4 / 4	6.4	7.2 D	--	7.295	95% Student's-tUCL	7.2	6.4
Selenium[a]	yes	yes	2 / 4	1.1	1.4 D	--	1.409	95% KM (t) UCL	1.4	1.1
Silver[a]	yes	yes	4 / 4	1.9	2.8 D	--	2.805	95% Student's-tUCL	2.8	1.9
Zinc[a]	yes	yes	4 / 4	1049	1,450 D	--	1,393	95% Student's-tUCL	1,393	1,049

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.17
Sediment EPCs at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Aluminum	yes	no	3 / 3	16,373	31,900 D	--	39,289	95% Student's-tUCL	31,900	16,373
Arsenic[a]	yes	yes	3 / 3	29.9	39.4 D	--	46.35	95% Student's-tUCL	39.4	29.9
Cadmium[a]	yes	yes	3 / 3	3.5	4.2 D	--	4.79	95% Student's-tUCL	4.2	3.5
Chromium[a]	no	yes	3 / 3	4.5	5.02 D	--	5.659	95% Student's-tUCL	5.0	4.5
Copper[a]	yes	yes	3 / 3	177	292 D	--	348.5	95% Student's-tUCL	292	177
Lead[a]	yes	yes	3 / 3	534	593 BD	--	639.4	95% Student's-tUCL	593	534
Manganese	yes	no	3 / 3	3,143	4,340 D	--	4,894	95% Student's-tUCL	4,340	3,143
Mercury[a]	no	yes	2 / 2	0.07	0.09 D	--	NA	NA	0.09	0.07
Nickel[a]	yes	yes	3 / 3	10.0	12.1 D	--	13.35	95% Student's-tUCL	12.1	10.0
Selenium[a]	yes	yes	1 / 3	2.9	2.9 D	--	NA	NA	2.9	2.9
Silver[a]	yes	yes	3 / 3	2.0	3.1 D	--	3.628	95% Student's-tUCL	3.1	2.0
Zinc[a]	yes	yes	3 / 3	1,114	1,720 D	--	2,035	95% Student's-tUCL	1,720	1,114

[a] This analyte is an "importantbioaccumulativecompound" (Table 4-2 in EPA-823-R-00-001)and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximumexposure
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.18
Sediment EPCs at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	15,428	29,900 D	--	27,525	95% Student's-tUCL	27,525	15,428
Arsenic[a]	yes	yes	4 / 4	19.4	28.5 D	--	26.98	95% Student's-tUCL	27.0	19.4
Cadmium[a]	yes	yes	4 / 4	4.8	6.75 D	--	6.443	95% Student's-tUCL	6.4	4.8
Chromium[a]	no	yes	4 / 4	4.2	4.99 BD	--	4.924	95% Student's-tUCL	4.9	4.2
Copper[a]	yes	yes	4 / 4	147	223 D	--	211.9	95% Student's-tUCL	212	147
Lead[a]	yes	yes	4 / 4	300	367 BD	--	374.8	95% Student's-tUCL	367	300
Manganese	yes	no	4 / 4	4,348	6,900 D	--	6,390	95% Student's-tUCL	6,390	4,348
Mercury[a]	no	yes	2 / 3	0.04	0.04 D	--	NA	NA	0.04	0.04
Nickel[a]	yes	yes	4 / 4	9.4	13.1 D	--	12.44	95% Student's-tUCL	12.4	9.4
Selenium[a]	yes	yes	2 / 4	1.2	1.4 D	--	1.505	95% KM (t) UCL	1.4	1.2
Silver[a]	yes	yes	4 / 4	1.1	1.4 D	--	1.427	95% Student's-tUCL	1.4	1.1
Zinc[a]	yes	yes	4 / 4	1,738	2,910 D	--	2,778	95% Student's-tUCL	2,778	1,738

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB (2/25/15)

Table 4.19
Sediment EPCs at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Aluminum	yes	no	3 / 3	20,820	48,600 D	--	61,382	95% Student's-tUCL	48,600	20,820
Arsenic[a]	yes	yes	3 / 3	19.9	37.2 D	--	45.39	95% Student's-tUCL	37.2	19.9
Cadmium[a]	yes	yes	3 / 3	5.0	10.5 D	--	13.03	95% Student's-tUCL	10.5	5.0
Chromium[a]	no	yes	3 / 3	5.2	5.45 BD	--	5.584	95% Student's-tUCL	5.5	5.2
Copper[a]	yes	yes	3 / 3	188	413 D	--	517	95% Student's-tUCL	413	188
Lead[a]	yes	yes	3 / 3	296	435 D	--	592.2	95% Student's-tUCL	435	296
Manganese	yes	no	3 / 3	2,743	3,820 D	--	4,332	95% Student's-tUCL	3,820	2,743
Mercury[a]	no	yes	2 / 2	0.07	0.07 D	--	NA	NA	0.07	0.07
Nickel[a]	yes	yes	3 / 3	9.7	16.5 D	--	19.64	95% Student's-tUCL	16.5	9.7
Selenium[a]	yes	yes	2 / 3	1.9	3.3 D	--	7.901	97.5% KM (Chebyshev) UCL	3.3	1.9
Silver[a]	yes	yes	3 / 3	1.4	2.2 D	--	2.816	95% Student's-tUCL	2.2	1.4
Zinc[a]	yes	yes	3 / 3	2,190	5,320 D	--	6,760	95% Student's-tUCL	5,320	2,190

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.20
Sediment EPCs at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	COPEC?		Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	1/2 Maximum non-detect	95% UCL of mean	UCL Calculation Method	Sediment EPCs	
	benthos	wildlife							RME	CTE
Metals (mg/kg)										
Aluminum	yes	no	4 / 4	20,025	37,400 D	--	37,463	95% Student's-tUCL	37,400	20,025
Arsenic[a]	yes	yes	4 / 4	21.9	29.7 D	--	30.11	95% Student's-tUCL	29.7	21.9
Cadmium[a]	yes	yes	4 / 4	10.1	18.6 D	--	19.21	95% Student's-tUCL	18.6	10.1
Chromium[a]	no	yes	4 / 4	5.4	7.38 BD	--	7.017	95% Student's-tUCL	7.0	5.4
Copper[a]	yes	yes	4 / 4	191	357 D	--	331.9	95% Student's-tUCL	332	191
Lead[a]	yes	yes	4 / 4	300	378 D	--	376.1	95% Student's-tUCL	376	300
Manganese	yes	no	4 / 4	7,425	13,100 D	--	13,563	95% Student's-tUCL	13,100	7,425
Mercury[a]	no	yes	3 / 3	0.04	0.06 D	--	0.07	95% Student's-tUCL	0.06	0.04
Nickel[a]	yes	yes	4 / 4	18.3	31.6 D	--	30.95	95% Student's-tUCL	31.0	18.3
Selenium[a]	yes	yes	2 / 4	2.1	3.1 D	--	3.088	95% Student's-tUCL	3.1	2.1
Silver[a]	yes	yes	4 / 4	1.3	1.7 D	--	1.654	95% Student's-tUCL	1.7	1.3
Zinc[a]	yes	yes	4 / 4	4,620	8,670 D	--	8,544	95% Student's-tUCL	8,544	4,620

[a] This analyte is an "important bioaccumulative compound" (Table 4-2 in EPA-823-R-00-001) and is retained for use in food chain modeling
mg/kg = milligram per kilogram
COPEC = chemicals of potential ecological concern
CTE = central tendency exposure
B = analyte was also detected in the blank
D = sample was diluted before analysis
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.21
Pore water EPCs for community-level receptors for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)		95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
							RME	CTE
Beryllium (dissolved)	0 / 1	1.0	1.0	U	NA	NA	1.0	1.0
Silver (dissolved)	0 / 1	0.25	0.25	U	NA	NA	0.25	0.25

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.22
Pore water EPCs for community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean*	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	8 / 11	1,259	6,170 D	4,514	95% Adjusted Gamma KM-UCL	4,514	1,259
Beryllium (dissolved)	0 / 11	2.2	10 U	NA	NA	10	2.2
Cadmium (dissolved)	11 / 11	23.6	106.5 D	93.35	95% Adjusted Gamma-UCL	93	24
Copper (dissolved)	11 / 11	224	2,250 D	2,242	95% Chebyshev (Mean, Sd) UCL	2,242	224
Lead (dissolved)	6 / 11	13.7	65.6 D	19.22	95% KM (Percentile Bootstrap) UCL	19	14
Manganese (dissolved)	10 / 11	17,912	78,300 D	115,211	95% GROS Adjusted Gamma-UCL	78,300	17,912
Selenium (dissolved)	0 / 11	1.6	5.0 U	NA	NA	5.0	1.6
Silver (dissolved)	0 / 11	0.8	2.5 U	NA	NA	2.5	0.8
Zinc (dissolved)	11 / 11	5,735	29,900 D	19,367	95% Adjusted Gamma-UCL	19,367	5,735

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.23
Pore water EPCs for community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	2 / 2	282	517	NA	NA	517	282
Beryllium (dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	2.19	2.98	NA	NA	3.0	2.2
Iron (dissolved)	1 / 2	338	338	NA	NA	338	338
Manganese (dissolved)	2 / 2	722	995	NA	NA	995	722
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	1,019	1,630	NA	NA	1,630	1,019

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.24
Pore water EPCs for community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolvedl)	2 / 2	26	29 J	NA	NA	29	26
Beryllium(dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	1.2	2.03	NA	NA	2.03	1.2
Iron (dissolved)	1 / 2	341	341	NA	NA	341	341
Manganese (dissolved)	2 / 2	936	1,870	NA	NA	1,870	936
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	536	709	NA	NA	709	536

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.25
Pore water EPCs for community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	0 / 1	10	10 U	NA	NA	10	10
Beryllium (dissolved)	0 / 1	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	0 / 1	0.05	0.05 U	NA	NA	0.05	0.05
Iron (dissolved)	0 / 1	50	50 U	NA	NA	50	50
Manganese (dissolved)	1 / 1	3.37	3.37 J	NA	NA	3.37	3.37
Silver (dissolved)	0 / 1	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	1 / 1	32.9	32.9	NA	NA	33	33

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.26
Pore water EPCs for community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (μg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolved)	2 / 2	34	40 J	NA	NA	40	34
Beryllium (dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	2 / 2	0.59	0.79	NA	NA	0.79	0.59
Iron (dissolved)	1 / 2	107	107 J	NA	NA	107	107
Manganese (dissolved)	2 / 2	238	290	NA	NA	290	238
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	182	190	NA	NA	190	182

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.27
Pore water EPCs for community-level receptors at Bakers Bridge in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (µg/L)	Frequency of Detection	Arithmetic Mean	Maximum Detect or 1/2 Max DL (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Aluminum (dissolvedl)	2 / 2	41	47 J	NA	NA	47	41
Beryllium(dissolved)	0 / 2	1.0	1.0 U	NA	NA	1.0	1.0
Cadmium (dissolved)	1 / 2	0.33	0.33	NA	NA	0.33	0.33
Iron (dissolved)	1 / 2	1,260	1,260	NA	NA	1,260	1,260
Manganese (dissolved)	2 / 2	3,098	5,870	NA	NA	5,870	3,098
Silver (dissolved)	0 / 2	0.25	0.25 U	NA	NA	0.25	0.25
Zinc (dissolved)	2 / 2	64	115	NA	NA	115	64

* when a COPEC is not detected in at least 1 sample the arthmetic mean is calculated using 1/2 the DL values.
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable because either the the dataset is too small and/or it contains too many non-detect values to calculate a 95%UCL
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration

prepared by: EC (3/6/15)
reviewed by: BB (3/9/15)

Table 4.28
Surface water EPCs for wildlife receptors foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	40 / 40	1.4	4.0	1.557	95% Modified-t UCL	1.6	1.4
Copper	32 / 40	15.5	33.5	16.2	95% KM (BCA) UCL	16.2	15.5
Lead	40 / 40	11.6	52.3	21.93	95% Chebyshev (Mean, SD) UCL	21.9	11.6
Zinc	40 / 40	432	1180	487.8	95% Modified-t UCL	488	432

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

RME = reasonable maximum exposure

95% UCL - 95% Upper Confidence Limit of mean concentration

The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.29
Surface water EPCs for wildlife receptors foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Arsenic	1 / 24	5.0	5.0	NA	NA	5.0	5.0
Cadmium	24 / 24	1.6	2.9	1.9	95% Student's-t UCL	1.9	1.6
Copper	23 / 24	27.4	46.7	30.66	95% KM (t) UCL	30.7	27.4
Lead	24 / 24	12.8	99.8	30.46	95% Chebyshev (MEAN, Sd) UCL	30.5	12.8
Nickel	9 / 24	5.0	7.0	3.713	95% KM (Percentile Bootstrap) UCL	3.7	5.0
Zinc	24 / 24	600	1320	711.4	95% Student's-t UCL	711	600

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.30
Surface water EPCs for wildlife receptors foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	5 / 5	1.5	2.2	2.1	95% Student's-t UCL	2.1	1.5
Copper	5 / 5	17.8	22.8	23.46	95% Student's-t UCL	22.8	17.8
Lead	5 / 5	11.1	33.7	23.41	95% Student's-t UCL	23.4	11.1
Nickel	1 / 5	3.8	3.8	NA	NA	3.8	3.8
Zinc	5 / 5	521	768	703.8	95% Student's-t UCL	704	521

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.31
Surface water EPCs for wildlife receptors foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs RME	Surface Water EPCs CTE
Total Metals (µg/L)							
Cadmium	2 / 4	1.0	1.5	NA	NA	1.5	1.0
Chromium	1 / 4	5.8	5.8	NA	NA	5.8	5.8
Copper	4 / 4	9.4	13.1	14.1	95% Student's-t UCL	13.1	9.4
Lead	4 / 4	5.5	11.7	10.6	95% Student's-t UCL	10.6	5.5
Nickel	1 / 4	2.9	2.9	NA	NA	2.9	2.9
Zinc	4 / 4	265	557	498	95% Student's-t UCL	498	265

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

NA = not applicable

RME = reasonable maximum exposure

95% UCL - 95% Upper Confidence Limit of the mean concentration

The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)

reviewed by: RI (2/10/14)

updated by: EC (2/20/15)

reviewed by: BB(2/25/15)

Table 4.32
Surface water EPCs for wildlife receptors foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	5 / 5	1.0	1.4	1.4	95% Student's-t UCL	1.4	1.0
Copper	5 / 5	13.8	20.6	19.7	95% Student's-t UCL	19.7	13.8
Lead	5 / 5	11.2	32.6	23.1	95% Student's-t UCL	23.1	11.2
Zinc	5 / 5	361	545	503.2	95% Student's-t UCL	503	361

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.33
Surface water EPCs for wildlife receptors foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	4 / 4	0.9	1.1	1.2	95% Student's-t UCL	1.1	0.9
Copper	4 / 4	12.2	21.5	22.6	95% Student's-t UCL	21.5	12.2
Lead	4 / 4	12.1	34.5	30.3	95% Student's-t UCL	30.3	12.1
Zinc	4 / 4	302	445	428.9	95% Student's-t UCL	429	302

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling

ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.34
Surface water EPCs for wildlife foraging at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs[a]	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	UCL Calculation Method	Surface Water EPCs	
						RME	CTE
Total Metals (µg/L)							
Cadmium	4 / 5	0.7	0.8	0.8	95% KM (t) UCL	0.8	0.7
Copper	4 / 5	9.5	16.3	13.8	95% KM (t) UCL	13.8	9.5
Lead	5 / 5	7.8	26.0	17.7	95% Student's-t UCL	17.7	7.8
Zinc	5 / 5	216	273	272.4	95% Student's-t UCL	272	216

[a] Only those analytes identified as "important bioaccumulative compounds" (Table 4-2 in EPA-823-R-00-001) and detected in at least one surface water sample are retained for food chain modeling
ug/L = microgram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
NA = not applicable
RME = reasonable maximum exposure
95% UCL - 95% Upper Confidence Limit of the mean concentration
The RME value is the lesser of the maximum detected value and the 95% UCL value.

prepared by: SJP (1/29/14)
reviewed by: RI (2/10/14)
updated by: EC (2/20/15)
reviewed by: BB(2/25/15)

Table 4.35
EDD formulas for the targeted wildlife receptors
Baseline Ecological Risk Assessment
Upper Animas Mining District

Avian insectivore - American dipper						
estimated daily dose (EDD_x)	=	**aquatic insect exposure** $FIR*FC_{inverts}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Avian omnivore - mallard#						
estimated daily dose (EDD_x)	=	**invertebrate and plant exposure**# $FIR[(FC_{invert}*PDF)+(FC_{plant}*PDF)]*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Avian piscivore - belted kingfisher						
estimated daily dose (EDD_x)	=	**fish exposure** $FIR*FC_{fish}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$		**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day
Mammalian herbivore - muskrat						
estimated daily dose (EDD_x)	=	**aquatic plant exposure** $FIR*FC_{plant}*PDF*AUF$	+	**surface water exposure** $WIR*WC_x*AUF$	+	**sediment exposure** $SIR*SC_x*AUF$
mg/kg BW-day		mg/kg BW-day		L/kg BW-day		mg/kg BW-day

The mallard is modeled for two diets: 100% benthic invertebrates to represent feeding by females during the egg-laying season, and an equal diet of benthic invertebrates (50%) and aquatic plants (50%) for the rest of the year.

FC_{xi} $=SC_x*AF_x$

Where: EDD_x = estimated daily dose of COPEC "x" (mg COPEC/kg BW-day)
FIR = food ingestion rate (kg dw/kg BW-day)
FC_{xi} = concentration of COPEC "x" in food item "i" (mg/kg dw)
PDF = proportion of diet composed of food type "i" (unitless)
WIR = water ingestion rate (L/day)
WC_x = concentration of COPEC "x" in surface water (mg/L)
SIR = sediment ingestion rate (kg dw/day)
SC_x = concentration of COPEC"x" in sediment (mg/kg [calculated as a receptor-specific fraction of the FIR])
BW = body weight (kg)
AUF = area use factor (unitless; assumed 1.0)

created by: SJP (1/9/14)
reviewed by:

Table 4.36
Exposure parameters for the four wildlife receptors used in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas Mining District

wildlife species	body weight (kg)	ingestion rates: food (kg/kg BW-day, dw)	ingestion rates: water (L/kg BW-day)	ingestion rates: sediment (kg/kg BW-day, dw)	dietary composition (%): aquatic invert.	dietary composition (%): fish	dietary composition (%): aquatic plants	home range
Aquatic Insectivorous Birds								
American dipper (*Cinclus mexicanus*)	0.0565[g]	0.2173[a]	0.152[e]	0.02173[n]	100[j]	--	--	759 m (along a water course)
Aquatic Herbivorous Mammals								
muskrat (*Ondatra zibethicus*)	1.17[h]	0.0839[b]	0.0975[f]	0.00839[n]	--	--	100[j]	0.13 hectares
Piscivorous Birds								
belted kingfisher (*Ceryle alcyon*)	0.147[i]	0.0869[c]	0.111[e]	0.00174[o]	--	100[j]	--	2.25 km
Omnivorous Birds								
mallard (*Anas platyrhynchos*)	1.162[i]	0.0519[d]	0.056[e]	0.00104[m]	100[k]	--	--	111 hectares
					50[l]	--	50[l]	

[a] Calculated using IR_{food} (g dw/day) = $0.398*BW(g)^{0.850}$, adjusted to 1.0 kg of receptor (see eq. 3-4 [passerines] on p. 3-4 in EPA, 1993)
[b] Calculated using IR_{food} (g dw/day) = $0.577*BW(g)^{0.727}$, adjusted to 1.0 kg of receptor (see eq. 3-9 [herbivores] on p. 3-6 in EPA, 1993)
[c] Calculated using IR_{food} (g dw/day) = $0.301*BW(g)^{0.751}$, adjusted to 1.0 kg of receptor (see eq. 3-5 [non-passerines] on p. 3-5 in EPA, 1993)
[d] Calculated using IR_{food} (g dw/day) = $0.301*BW(g)^{0.751}$, adjusted to 1.0 kg of receptor (see eq. 3-5 [non-passerines] on p. 3-5 in EPA, 1993)
[e] Calculated using IR_{water} (L/day) = $0.059*BW(kg)^{0.67}$, adjusted to 1.0 kg of receptor (see eq. 3-15 [all birds] on p. 3-8 in EPA, 1993)
[f] Calculated using IR_{water} (L/day) = $0.099*BW(kg)^{0.90}$, adjusted to 1.0 kg of receptor (see eq. 3-17 [all mammals] on p. 3-10 in EPA, 1993)
[g] Ealey, D., 1977
[h] Silva and Downing, 1995
[i] EPA, 1993
[j] Conservative assumption
[k] the100% aquatic invertebrate diet is for females foraging prior to egg production in the spring
[l] the 50% aquatic invertebrates + 50% aquatic plants represents an average mallard diet for the rest of the year.
[m] Table 4-4 in EPA, 1993 (value represents 2% of food intake on a dry-weight basis)
[n] best professional judgment (value represents 10% of food intake on a dry-weight basis)
[o] best professional judgment (value represents 2% of food intake on a dry-weight basis)
BW - Body weight
dw - dry weight

created by: SJP (1/9/14)
reviewed by:

Table 4.37
Soil-to-plant regression models and uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	soil-to-plant regression models (dry weight)[a]		soil-to-plant uptake factors (dry weight)[a]		
	model	reference	value	basis	reference
arsenic	$C_p = e^{(-1.992 + 0.564(\ln Cs))}$	Bechtel Jacobs, 1998 (Table 7)	regression model available		
cadmium	$C_p = e^{(-0.476 + 0.546(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		
chromium	--		0.041	median	USEPA, 2007 (Table 4a)
copper	$C_p = e^{(0.669 + 0.394(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		
lead	$C_p = e^{(-1.328 + 0.561(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		
mercury	$C_p = e^{(-0.996 + 0.544(\ln Cs))}$	Bechtel Jacobs, 1998 (Table 7)	regression model available		
nickel	$C_p = e^{(-2.224 + 0.748(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		
selenium	$C_p = e^{(-0.678 + 1.104(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		
silver	--		0.014	median	USEPA, 2007 (Table 4a)
zinc	$C_p = e^{(1.575 + 0.555(\ln Cs))}$	USEPA, 2007 (Table 4a)	regression model available		

[a] Tissue residue levels in the above-ground vegetative portion of rooted aquatic plants were estimated using the methods developed for terrestrial plants, except that sediment exposure point concentrations were used in the calculations

[b] C_p = concentration of an analyte in the plant; C_s = concentration of an analyte in the sediment

References:

Bechtel Jacobs. 1998. Empirical models for the uptake of inorganic chemicals from soil by plants. Prepared for the U.S. Department of Energy. BJC/OR-133. September 1998.

U.S. Environmental Protection Agency (USEPA). 2007j. Guidance for developing ecological soil screening levels. Attachment 4-1. OSWER Directive 9285.7-55. April

prepared by: SJP (12/2/13)

reviewed by:

Table 4.38
Sediment-to-benthic invertebrate regression models and uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	sediment-to-benthicinvert. regression models (dry weight)		sediment-to-benthicinvertebrate uptake factors (dry weight)		
	model[a]	reference	value	basis	reference
arsenic	$C_i = 10^{(-0.292 + 0.754(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - all)	regression model available		
cadmium	$C_i = 10^{(-0.314 + 0.513(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - dep)	regression model available		
chromium	$C_i = 10^{(0.2092 + 0.365(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - all)	regression model available		
copper	--		0.824	geometric mean	Bechtel Jacobs, 1998 (Table 2 - dep)
lead	$C_i = 10^{(-0.515 + 0.653(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - dep)	regression model available		
mercury	--		1.186	geometric mean	Bechtel Jacobs, 1998 (Table 2 - all)
nickel	$C_i = 10^{(-0.440 + 0.695(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - dep)	regression model available		
selenium	--		1.00	assumed	
silver	--		0.18	mean	Hirsch, 1998
zinc	$C_i = 10^{(1.89 + 0.126(\log Csd))}$	Bechtel Jacobs, 1998 (Table 3 - dep)	regression model available		

[a] C_p = concentration of an analyte in the plant; C_s = concentration of an analyte in the sediment

References:

Bechtel Jacobs, 1998. Biota sediment accumulation factors for invertebrates: review and recommendations for Oak Ridge Reservation. Prepared for U.S. Department of Energy. BJC/OR-112. August 1998.

Hirsch, M.P. 1998. Bioaccumulation of silver from laboratory-spiked sediments in the oligochaete (*Lumbriculus variegatus*). Environ. Toxicol. Chem. 17:605-609.

prepared by: SJP (12/2/13)
reviewed by:

Table 4.39
Sediment-to-fish uptake factors for use in food chain modeling
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Analyte	sediment-to-fish regression models (dry weight)		Sediment bioaccumulation factors for fish (dry weight)		
	model	reference	value	basis	reference
arsenic	no regression model available		0.126	average	Pascoe *et al* ., 1996
cadmium	no regression model available		0.164	average	Pascoe *et al.* , 1996
chromium	no regression model available		0.038	average	Krantzberg and Boyd, 1992
copper	no regression model available		0.100	average	Krantzberg and Boyd, 1992
lead	no regression model available		0.070	average	Krantzberg and Boyd, 1992
mercury	no regression model available		3.25	average	Cope *et al.* , 1990
nickel	no regression model available		1.00	assumed	--
selenium	no regression model available		1.00	assumed	--
silver	no regression model available		1.00	assumed	--
zinc	no regression model available		0.147	average	Pascoe *et al.* , 1996

References:

Cope, W.G., J.G. Wiener, and R.G. Rada. 1990. Mercury accumulation in yellow perch in Wisconsin seepage lakes: relation to lake characteristics. Environ. Toxicol. Chem. 9:931-940.

Krantzberg, G. and D. Boyd. 1992. The biological significance of contaminants in sediment from Hamilton Harbour, Lake Ontario. Environ. Toxicol. Chem. 11:1527-1540.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. Food chain analysis of exposures and risks to wildlife at a metals-contaminated wetland. Arch. Environ. Contam. Toxicol. 30:306-318.

prepared by: SJP (2/2/14)

reviewed by:

Table 4.40
Estimated daily doses for the American dipper foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	34.2	0.000	2.10	0.9	0.1	4.11E-01	7.43E-02	0.00E+00	4.85E-01	27.4	0.000	1.27	0.9	0.1	2.48E-01	5.95E-02	0.00E+00	3.07E-01
Cadmium	12.9	0.0016	3.86	0.9	0.1	7.55E-01	2.80E-02	2.43E-04	7.84E-01	11.1	0.0014	2.84	0.9	0.1	5.55E-01	2.41E-02	2.13E-04	5.80E-01
Chromium	5.0	0.000	2.78	0.9	0.1	5.43E-01	1.09E-02	0.00E+00	5.54E-01	4.7	0.000	2.56	0.9	0.1	5.00E-01	1.02E-02	0.00E+00	5.11E-01
Copper	399	0.0162	64.9	0.9	0.1	1.27E+01	8.67E-01	2.46E-03	1.36E+01	339	0.0155	62.4	0.9	0.1	1.22E+01	7.37E-01	2.36E-03	1.30E+01
Lead	1733	0.0219	25.2	0.9	0.1	4.93E+00	3.77E+00	3.33E-03	8.70E+00	1508	0.0116	21.3	0.9	0.1	4.17E+00	3.28E+00	1.76E-03	7.45E+00
Mercury	0.10	0.000	0.09	0.9	0.1	1.72E-02	2.17E-04	0.00E+00	1.74E-02	0.07	0.000	0.09	0.9	0.1	1.66E-02	1.52E-04	0.00E+00	1.68E-02
Nickel	9.2	0.000	0.52	0.9	0.1	1.01E-01	2.00E-02	0.00E+00	1.21E-01	8.2	0.000	0.52	0.9	0.1	1.01E-01	1.78E-02	0.00E+00	1.19E-01
Selenium	1.0	0.000	0.88	0.9	0.1	1.72E-01	2.17E-03	0.00E+00	1.75E-01	1.5	0.000	0.88	0.9	0.1	1.72E-01	3.26E-03	0.00E+00	1.76E-01
Silver	6.4	0.000	0.22	0.9	0.1	4.30E-02	1.39E-02	0.00E+00	5.69E-02	5.5	0.000	0.21	0.9	0.1	4.15E-02	1.20E-02	0.00E+00	5.34E-02
Zinc	4054	0.488	799	0.9	0.1	1.56E+02	8.81E+00	7.42E-02	1.65E+02	3172	0.432	579	0.9	0.1	1.13E+02	6.89E+00	6.57E-02	1.20E+02

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day- milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
QC'd by: 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.41
EDDs for the American dipper foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	39.6	0.0050	0.27	0.9	0.1	5.20E-02	8.61E-02	7.60E-04	1.39E-01	33.4	0.0050	0.27	0.9	0.1	5.20E-02	7.26E-02	7.60E-04	1.25E-01
Cadmium	2.9	0.0019	0.68	0.9	0.1	1.33E-01	6.30E-03	2.89E-04	1.39E-01	2.1	0.0016	0.68	0.9	0.1	1.33E-01	4.56E-03	2.43E-04	1.38E-01
Chromium	6.1	0.000	2.16	0.9	0.1	4.23E-01	1.33E-02	0.00E+00	4.36E-01	4.6	0.000	2.16	0.9	0.1	4.23E-01	1.00E-02	0.00E+00	4.33E-01
Copper	173	0.0307	38	0.9	0.1	7.49E+00	3.76E-01	4.67E-03	7.87E+00	137	0.0274	38	0.9	0.1	7.49E+00	2.98E-01	4.16E-03	7.79E+00
Lead	581	0.0305	7.6	0.9	0.1	1.48E+00	1.26E+00	4.64E-03	2.75E+00	478	0.0128	7.6	0.9	0.1	1.48E+00	1.04E+00	1.95E-03	2.52E+00
Mercury	0.070	0.000	0.11	0.9	0.1	2.09E-02	1.52E-04	0.00E+00	2.11E-02	0.06	0.000	0.11	0.9	0.1	2.09E-02	1.30E-04	0.00E+00	2.11E-02
Nickel	5.9	0.0037	0.27	0.9	0.1	5.20E-02	1.28E-02	5.62E-04	6.54E-02	5.1	0.0050	0.27	0.9	0.1	5.20E-02	1.11E-02	7.60E-04	6.39E-02
Selenium	1.9	0.000	0.53	0.9	0.1	1.04E-01	4.13E-03	0.00E+00	1.09E-01	1.5	0.000	0.53	0.9	0.1	1.04E-01	3.26E-03	0.00E+00	1.08E-01
Silver	2.4	0.000	0.27	0.9	0.1	5.20E-02	5.22E-03	0.00E+00	5.72E-02	1.9	0.000	0.27	0.9	0.1	5.20E-02	4.13E-03	0.00E+00	5.62E-02
Zinc	819	0.711	166	0.9	0.1	3.25E+01	1.78E+00	1.08E-01	3.44E+01	651	0.600	166	0.9	0.1	3.25E+01	1.41E+00	9.12E-02	3.40E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day- milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.42
EDDs for the American dipper foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD [4]
Arsenic	33.8	0.000	0.69	0.9	0.1	1.36E-01	7.34E-02	0.00E+00	2.09E-01	27.9	0.000	0.69	0.9	0.1	1.36E-01	6.06E-02	0.00E+00	1.96E-01
Cadmium	5.4	0.0021	0.94	0.9	0.1	1.83E-01	1.17E-02	3.19E-04	1.95E-01	4.0	0.0015	0.94	0.9	0.1	1.83E-01	8.69E-03	2.28E-04	1.92E-01
Chromium	5.4	0.000	2.03	0.9	0.1	3.97E-01	1.17E-02	0.00E+00	4.09E-01	4.0	0.000	2.03	0.9	0.1	3.97E-01	8.69E-03	0.00E+00	4.06E-01
Copper	284	0.0228	33	0.9	0.1	6.50E+00	6.17E-01	3.47E-03	7.12E+00	199	0.0178	33	0.9	0.1	6.50E+00	4.32E-01	2.71E-03	6.93E+00
Lead	729	0.0234	6.7	0.9	0.1	1.32E+00	1.58E+00	3.56E-03	2.90E+00	513	0.0111	6.7	0.9	0.1	1.32E+00	1.11E+00	1.69E-03	2.43E+00
Mercury	0.05	0.000	0.11	0.9	0.1	2.15E-02	1.09E-04	0.00E+00	2.16E-02	0.04	0.000	0.11	0.9	0.1	2.15E-02	8.69E-05	0.00E+00	2.16E-02
Nickel	7.2	0.0038	0.58	0.9	0.1	1.13E-01	1.56E-02	5.78E-04	1.29E-01	6.4	0.0038	0.58	0.9	0.1	1.13E-01	1.39E-02	5.78E-04	1.27E-01
Selenium	1.4	0.000	0.55	0.9	0.1	1.07E-01	3.04E-03	0.00E+00	1.10E-01	1.1	0.000	0.55	0.9	0.1	1.07E-01	2.39E-03	0.00E+00	1.10E-01
Silver	2.8	0.000	0.28	0.9	0.1	5.38E-02	6.08E-03	0.00E+00	5.99E-02	1.9	0.000	0.28	0.9	0.1	5.38E-02	4.13E-03	0.00E+00	5.79E-02
Zinc	1393	0.704	197	0.9	0.1	3.86E+01	3.03E+00	1.07E-01	4.18E+01	1049	0.521	197	0.9	0.1	3.86E+01	2.28E+00	7.92E-02	4.10E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$

2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$

3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

4 $\text{Total EDD} = Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.43
EDDS for the American dipper foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	39.4	0.000	Equation	8.15	0.9	0.1	1.59E+00	8.56E-02	0.00E+00	1.68E+00	29.9	0.000	Equation	6.62	0.9	0.1	1.29E+00	6.50E-02	0.00E+00	1.36E+00
Cadmium	4.2	0.0015	Equation	1.01	0.9	0.1	1.98E-01	9.13E-03	2.28E-04	2.08E-01	3.5	0.0010	Equation	0.92	0.9	0.1	1.80E-01	7.61E-03	1.52E-04	1.88E-01
Chromium	5.0	0.0058	Equation	2.91	0.9	0.1	5.70E-01	1.09E-02	8.82E-04	5.81E-01	4.5	0.0058	Equation	2.80	0.9	0.1	5.48E-01	9.78E-03	8.82E-04	5.59E-01
Copper	292	0.0131	0.824	241	0.9	0.1	4.71E+01	6.35E-01	1.99E-03	4.77E+01	177	0.0094	0.824	145.848	0.9	0.1	2.85E+01	3.85E-01	1.43E-03	2.89E+01
Lead	593	0.0106	Equation	19.8	0.9	0.1	3.86E+00	1.29E+00	1.61E-03	5.15E+00	534	0.0055	Equation	18.5	0.9	0.1	3.61E+00	1.16E+00	8.36E-04	4.77E+00
Mercury	0.09	0.000	1.186	0.11	0.9	0.1	2.09E-02	1.96E-04	0.00E+00	2.11E-02	0.07	0.000	1.186	0.08	0.9	0.1	1.62E-02	1.52E-04	0.00E+00	1.64E-02
Nickel	12.1	0.0029	Equation	2.05	0.9	0.1	4.02E-01	2.63E-02	4.41E-04	4.28E-01	10.0	0.0029	Equation	1.80	0.9	0.1	3.52E-01	2.17E-02	4.41E-04	3.74E-01
Selenium	2.9	0.000	1.00	2.90	0.9	0.1	5.67E-01	6.30E-03	0.00E+00	5.73E-01	2.9	0.000	1.00	2.90	0.9	0.1	5.67E-01	6.30E-03	0.00E+00	5.73E-01
Silver	3.1	0.000	0.18	0.56	0.9	0.1	1.09E-01	6.74E-03	0.00E+00	1.16E-01	2.0	0.000	0.18	0.36	0.9	0.1	7.04E-02	4.35E-03	0.00E+00	7.48E-02
Zinc	1720	0.498	Equation	198	0.9	0.1	3.88E+01	3.74E+00	7.57E-02	4.26E+01	1114	0.265	Equation	188	0.9	0.1	3.67E+01	2.42E+00	4.03E-02	3.92E+01

mg/kg - milligrams per kilogram
mg/L - milligramsper liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-to-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
Where $C_{invert} = (EPC_{sediment} \times BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 $Total\ EDD = Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.44
EDDS for the American dipper foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF$_{Invert}$	Df$_{sediment}$	Dose$_{invert}$[1]	Dose$_{sed}$[2]	Dose$_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF$_{Invert}$	Df$_{sediment}$	Dose$_{invert}$[1]	Dose$_{sed}$[2]	Dose$_{water}$[3]	Total EDD[4]
Arsenic	27.0	0.000	0.61	0.9	0.1	1.20E-01	5.87E-02	0.00E+00	1.79E-01	19.4	0.000	0.61	0.9	0.1	1.20E-01	4.22E-02	0.00E+00	1.62E-01
Cadmium	6.4	0.0014	0.78	0.9	0.1	1.53E-01	1.39E-02	2.13E-04	1.67E-01	4.8	0.0010	0.78	0.9	0.1	1.53E-01	1.04E-02	1.52E-04	1.64E-01
Chromium	4.9	0.000	3.26	0.9	0.1	6.37E-01	1.06E-02	0.00E+00	6.48E-01	4.2	0.000	3.26	0.9	0.1	6.37E-01	9.13E-03	0.00E+00	6.46E-01
Copper	212	0.0197	15	0.9	0.1	2.94E+00	4.61E-01	2.99E-03	3.41E+00	147	0.0138	15	0.9	0.1	2.94E+00	3.19E-01	2.10E-03	3.27E+00
Lead	367	0.0231	2.3	0.9	0.1	4.49E-01	7.97E-01	3.51E-03	1.25E+00	300	0.0112	2.3	0.9	0.1	4.49E-01	6.52E-01	1.70E-03	1.10E+00
Mercury	0.04	0.000	0.25	0.9	0.1	4.79E-02	8.69E-05	0.00E+00	4.80E-02	0.04	0.000	0.25	0.9	0.1	4.79E-02	8.69E-05	0.00E+00	4.80E-02
Nickel	12.4	0.000	0.61	0.9	0.1	1.20E-01	2.69E-02	0.00E+00	1.47E-01	9.4	0.000	0.61	0.9	0.1	1.20E-01	2.04E-02	0.00E+00	1.40E-01
Selenium	1.4	0.000	1.22	0.9	0.1	2.39E-01	3.04E-03	0.00E+00	2.42E-01	1.20	0.000	1.22	0.9	0.1	2.39E-01	2.61E-03	0.00E+00	2.42E-01
Silver	1.4	0.000	0.61	0.9	0.1	1.20E-01	3.04E-03	0.00E+00	1.23E-01	1.1	0.000	0.61	0.9	0.1	1.20E-01	2.39E-03	0.00E+00	1.22E-01
Zinc	2778	0.503	187	0.9	0.1	3.66E+01	6.04E+00	7.65E-02	4.27E+01	1738	0.361	187	0.9	0.1	3.66E+01	3.78E+00	5.49E-02	4.04E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day- milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.45
EDDs for the American dipper foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* ExposurePoint Concentration		EDD (mg/kg bw-day)								CTE** ExposurePoint Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Invert tissue concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	37.2	0.000	Equation	7.80	0.9	0.1	1.53E+00	8.08E-02	0.00E+00	1.61E+00	19.9	0.000	Equation	4.87	0.9	0.1	9.52E-01	4.32E-02	0.00E+00	9.95E-01
Cadmium	10.5	0.0011	Equation	1.62	0.9	0.1	3.17E-01	2.28E-02	1.67E-04	3.40E-01	5.0	0.0009	Equation	1.11	0.9	0.1	2.17E-01	1.09E-02	1.37E-04	2.28E-01
Chromium	5.5	0.000	Equation	3.02	0.9	0.1	5.90E-01	1.20E-02	0.00E+00	6.02E-01	5.2	0.000	Equation	2.95	0.9	0.1	5.78E-01	1.13E-02	0.00E+00	5.89E-01
Copper	413	0.0215	0.824	340	0.9	0.1	6.66E+01	8.97E-01	3.27E-03	6.75E+01	188	0.0122	0.824	154.912	0.9	0.1	3.03E+01	4.09E-01	1.85E-03	3.07E+01
Lead	435	0.0303	Equation	16.1	0.9	0.1	3.16E+00	9.45E-01	4.61E-03	4.11E+00	296	0.0121	Equation	12.6	0.9	0.1	2.46E+00	6.43E-01	1.84E-03	3.10E+00
Mercury	0.07	0.000	1.186	0.08	0.9	0.1	1.62E-02	1.52E-04	0.00E+00	1.64E-02	0.07	0.000	1.186	0.08	0.9	0.1	1.62E-02	1.52E-04	0.00E+00	1.64E-02
Nickel	16.5	0.000	Equation	2.55	0.9	0.1	4.98E-01	3.59E-02	0.00E+00	5.34E-01	9.7	0.000	Equation	1.76	0.9	0.1	3.44E-01	2.11E-02	0.00E+00	3.66E-01
Selenium	3.3	0.000	1.00	3.30	0.9	0.1	6.45E-01	7.17E-03	0.00E+00	6.53E-01	1.9	0.000	1.00	1.90	0.9	0.1	3.72E-01	4.13E-03	0.00E+00	3.76E-01
Silver	2.2	0.000	0.18	0.40	0.9	0.1	7.74E-02	4.78E-03	0.00E+00	8.22E-02	1.4	0.000	0.18	0.25	0.9	0.1	4.93E-02	3.04E-03	0.00E+00	5.23E-02
Zinc	5320	0.429	Equation	229	0.9	0.1	4.47E+01	1.16E+01	6.52E-02	5.64E+01	2190	0.302	Equation	205	0.9	0.1	4.00E+01	4.76E+00	4.59E-02	4.48E+01

mg/kg - milligrams per kilogram
mg/L - milligramsper liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-to-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
Where $C_{invert} = (EPC_{sediment} \times BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
IR_{diet} (kg/kg BW-day, dw)	0.2173
IR_{water} (L/kg BW-day)	0.152
$IR_{sediment}$ (kg/kg BW-day, dw)	0.02173

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.46
EDDs for the American dipper foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	Invert tissue concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	29.7	0.000	0.23	0.9	0.1	4.52E-02	6.45E-02	0.00E+00	1.10E-01	21.9	0.000	0.23	0.9	0.1	4.52E-02	4.76E-02	0.00E+00	9.28E-02
Cadmium	18.6	0.0008	1.59	0.9	0.1	3.11E-01	4.04E-02	1.22E-04	3.52E-01	10.1	0.0007	1.59	0.9	0.1	3.11E-01	2.19E-02	1.06E-04	3.33E-01
Chromium	7.0	0.000	2.05	0.9	0.1	4.01E-01	1.52E-02	0.00E+00	4.16E-01	5.4	0.000	2.05	0.9	0.1	4.01E-01	1.17E-02	0.00E+00	4.12E-01
Copper	332	0.0138	17.6	0.9	0.1	3.44E+00	7.21E-01	2.10E-03	4.16E+00	191	0.0095	17.6	0.9	0.1	3.44E+00	4.15E-01	1.44E-03	3.85E+00
Lead	376	0.0177	2.53	0.9	0.1	4.96E-01	8.17E-01	2.69E-03	1.32E+00	300	0.0078	2.53	0.9	0.1	4.96E-01	6.52E-01	1.19E-03	1.15E+00
Mercury	0.06	0.000	0.09	0.9	0.1	1.82E-02	1.30E-04	0.00E+00	1.83E-02	0.04	0.000	0.09	0.9	0.1	1.82E-02	8.69E-05	0.00E+00	1.83E-02
Nickel	31.0	0.000	1.59	0.9	0.1	3.11E-01	6.74E-02	0.00E+00	3.78E-01	18.3	0.000	1.59	0.9	0.1	3.11E-01	3.98E-02	0.00E+00	3.50E-01
Selenium	3.1	0.000	0.47	0.9	0.1	9.09E-02	6.74E-03	0.00E+00	9.77E-02	2.1	0.000	0.47	0.9	0.1	9.09E-02	4.56E-03	0.00E+00	9.55E-02
Silver	1.7	0.000	0.23	0.9	0.1	4.52E-02	3.69E-03	0.00E+00	4.89E-02	1.3	0.000	0.23	0.9	0.1	4.52E-02	2.82E-03	0.00E+00	4.80E-02
Zinc	8544	0.272	353	0.9	0.1	6.90E+01	1.86E+01	4.13E-02	8.76E+01	4620	0.216	353	0.9	0.1	6.90E+01	1.00E+01	3.28E-02	7.91E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day- milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{invert} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{diet} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.0565
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.2173
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.152
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.02173

Created by: EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.47
EDDs for the Mallard foraging on the Animas River above Cement Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Metals																		
Arsenic	34.2	0.000	2.10	0.98	0.02	1.07E-01	7.11E-04	0.00E+00	1.08E-01	27.4	0.000	1.27	0.98	0.02	6.44E-02	5.70E-04	0.00E+00	6.50E-02
Cadmium	12.9	0.0016	3.86	0.98	0.02	1.96E-01	2.68E-04	8.96E-05	1.97E-01	11.1	0.0014	2.84	0.98	0.02	1.44E-01	2.31E-04	7.84E-05	1.45E-01
Chromium	5.0	0.000	2.78	0.98	0.02	1.41E-01	1.04E-04	0.00E+00	1.41E-01	4.7	0.000	2.56	0.98	0.02	1.30E-01	9.78E-05	0.00E+00	1.30E-01
Copper	399	0.0162	64.9	0.98	0.02	3.30E+00	8.30E-03	9.07E-04	3.31E+00	339	0.0155	62.4	0.98	0.02	3.18E+00	7.05E-03	8.68E-04	3.18E+00
Lead	1733	0.0219	25.2	0.98	0.02	1.28E+00	3.60E-02	1.23E-03	1.32E+00	1508	0.0116	21.3	0.98	0.02	1.09E+00	3.14E-02	6.50E-04	1.12E+00
Mercury	0.10	0.000	0.09	0.98	0.02	4.48E-03	2.08E-06	0.00E+00	4.48E-03	0.07	0.000	0.09	0.98	0.02	4.32E-03	1.46E-06	0.00E+00	4.32E-03
Nickel	9.2	0.000	0.52	0.98	0.02	2.62E-02	1.91E-04	0.00E+00	2.64E-02	8.2	0.000	0.52	0.98	0.02	2.62E-02	1.71E-04	0.00E+00	2.64E-02
Selenium	1.0	0.000	0.88	0.98	0.02	4.49E-02	2.08E-05	0.00E+00	4.49E-02	1.5	0.000	0.88	0.98	0.02	4.49E-02	3.12E-05	0.00E+00	4.49E-02
Silver	6.4	0.000	0.22	0.98	0.02	1.12E-02	1.33E-04	0.00E+00	1.13E-02	5.5	0.000	0.21	0.98	0.02	1.08E-02	1.14E-04	0.00E+00	1.09E-02
Zinc	4054	0.488	799	0.98	0.02	4.06E+01	8.43E-02	2.73E-02	4.08E+01	3172	0.432	579	0.98	0.02	2.95E+01	6.60E-02	2.42E-02	2.96E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day- milligramsper kilogramof body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - ReasonableMaximumExposure
CTE - Central TendencyExposure
DF - Dose Fraction
* The RME value representsthe 95% UCL or the maximumdetected concentrationif a 95% UCL could not be calculated.
** The CTE values representsthe mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} X C_{invert} X DF_{invert} X AUF$
2 $Dose_{sed} = Ir_{sediment} X EPC_{sediment} X Df_{sed} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) (kg) 1.162
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw) 0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day) 0.056
$\mathbf{IR_{sed}}$ (kg/kg DW-day,dw) 0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by: EC 3/01/15
QC'd by: RI 3/3/15

Table 4.48

EDDs for mallards foraging at sampling location A72 on the Animas River below Mineral Creek (100% benthic invert diet)

Baseline Ecological Risk Assessment

Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	39.6	0.0050	0.27	0.98	0.02	1.35E-02	8.24E-04	2.80E-04	1.46E-02	33.4	0.0050	0.27	0.98	0.02	1.35E-02	6.95E-04	2.80E-04	1.45E-02
Cadmium	2.9	0.0019	0.68	0.98	0.02	3.45E-02	6.03E-05	1.06E-04	3.47E-02	2.1	0.0016	0.68	0.98	0.02	3.45E-02	4.37E-05	8.96E-05	3.47E-02
Chromium	6.1	0.000	2.16	0.98	0.02	1.10E-01	1.27E-04	0.00E+00	1.10E-01	4.6	0.000	2.16	0.98	0.02	1.10E-01	9.57E-05	0.00E+00	1.10E-01
Copper	173	0.0307	38	0.98	0.02	1.95E+00	3.60E-03	1.72E-03	1.95E+00	137	0.0274	38	0.98	0.02	1.95E+00	2.85E-03	1.53E-03	1.95E+00
Lead	581	0.0305	7.6	0.98	0.02	3.84E-01	1.21E-02	1.71E-03	3.98E-01	478	0.0128	7.6	0.98	0.02	3.84E-01	9.94E-03	7.17E-04	3.95E-01
Mercury	0.07	0.000	0.11	0.98	0.02	5.44E-03	1.46E-06	0.00E+00	5.44E-03	0.06	0.000	0.11	0.98	0.02	5.44E-03	1.25E-06	0.00E+00	5.44E-03
Nickel	5.9	0.0037	0.27	0.98	0.02	1.35E-02	1.23E-04	2.07E-04	1.39E-02	5.1	0.0050	0.27	0.98	0.02	1.35E-02	1.06E-04	2.80E-04	1.39E-02
Selenium	1.9	0.000	0.53	0.98	0.02	2.72E-02	3.95E-05	0.00E+00	2.72E-02	1.5	0.000	0.53	0.98	0.02	2.72E-02	3.12E-05	0.00E+00	2.72E-02
Silver	2.4	0.000	0.27	0.98	0.02	1.35E-02	4.99E-05	0.00E+00	1.36E-02	1.9	0.000	0.27	0.98	0.02	1.35E-02	3.95E-05	0.00E+00	1.36E-02
Zinc	819	0.711	166	0.98	0.02	8.45E+00	1.70E-02	3.98E-02	8.51E+00	651	0.600	166	0.98	0.02	8.45E+00	1.35E-02	3.36E-02	8.50E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligramsper kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
IR_{sed} (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.49
EDDs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	RME* Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: Invert Tissue Concentration (dw)	Diet: DF_{Invert}	Diet: $Df_{sediment}$	Diet: Dose $_{invert}$ [1]	Sediment: Dose $_{sed}$ [2]	Water: $Dose_{water}$ [3]	Total EDD[4]	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	CTE** Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: Invert Tissue Concentration (dw)	Diet: DF_{Invert}	Diet: $Df_{sediment}$	Diet: Dose $_{invert}$ [1]	Sediment: Dose $_{sed}$ [2]	Water: $Dose_{water}$ [3]	Total EDD[4]
Arsenic	33.8	0.0000	0.69	0.98	0.02	3.52E-02	7.03E-04	0.00E+00	3.60E-02	27.9	0.0000	0.69	0.98	0.02	3.52E-02	5.80E-04	0.00E+00	3.58E-02
Cadmium	5.4	0.0021	0.94	0.98	0.02	4.76E-02	1.12E-04	1.18E-04	4.78E-02	4.0	0.0015	0.94	0.98	0.02	4.76E-02	8.32E-05	8.40E-05	4.78E-02
Chromium	5.4	0.000	2.03	0.98	0.02	1.03E-01	1.12E-04	0.00E+00	1.03E-01	4.0	0.000	2.03	0.98	0.02	1.03E-01	8.32E-05	0.00E+00	1.03E-01
Copper	284	0.0228	33.2	0.98	0.02	1.69E+00	5.91E-03	1.28E-03	1.70E+00	199	0.0178	33.2	0.98	0.02	1.69E+00	4.14E-03	9.97E-04	1.70E+00
Lead	729	0.0234	6.7	0.98	0.02	3.42E-01	1.52E-02	1.31E-03	3.59E-01	513	0.0111	6.7	0.98	0.02	3.42E-01	1.07E-02	6.22E-04	3.53E-01
Mercury	0.05	0.000	0.11	0.98	0.02	5.59E-03	1.04E-06	0.00E+00	5.60E-03	0.04	0.000	0.11	0.98	0.02	5.59E-03	8.32E-07	0.00E+00	5.60E-03
Nickel	7.2	0.0038	0.58	0.98	0.02	2.93E-02	1.50E-04	2.13E-04	2.97E-02	6.4	0.0038	0.58	0.98	0.02	2.93E-02	1.33E-04	2.13E-04	2.96E-02
Selenium	1.4	0.000	0.55	0.98	0.02	2.79E-02	2.91E-05	0.00E+00	2.80E-02	1.1	0.000	0.55	0.98	0.02	2.79E-02	2.29E-05	0.00E+00	2.79E-02
Silver	2.8	0.000	0.28	0.98	0.02	1.40E-02	5.82E-05	0.00E+00	1.40E-02	1.9	0.000	0.28	0.98	0.02	1.40E-02	3.95E-05	0.00E+00	1.40E-02
Zinc	1393	0.704	197	0.98	0.02	1.00E+01	2.90E-02	3.94E-02	1.01E+01	1049	0.521	197	0.98	0.02	1.00E+01	2.18E-02	2.92E-02	1.01E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentrationif a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 $Total\ EDD = Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sed}}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.50
EDDs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (100% benthic invertebrate diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	RME* Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Diet: Invert Tissue Concentration ($C_{invert, dw}$)	Diet: DF_{Invert}	Diet: $Df_{sediment}$	Diet: $Dose_{invert}$ [1]	Sediment: $Dose_{sed}$ [2]	Water: $Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.4	0.000	Equation	8.15	0.98	0.02	4.14E-01	8.20E-04	0.00E+00	4.15E-01
Cadmium	4.2	0.0015	Equation	1.01	0.98	0.02	5.15E-02	8.74E-05	8.40E-05	5.17E-02
Chromium	5.0	0.0058	Equation	2.91	0.98	0.02	1.48E-01	1.04E-04	3.25E-04	1.49E-01
Copper	292	0.0131	0.824	241	0.98	0.02	1.22E+01	6.07E-03	7.34E-04	1.22E+01
Lead	593	0.0106	Equation	19.8	0.98	0.02	1.01E+00	1.23E-02	5.94E-04	1.02E+00
Mercury	0.09	0.000	Equation	1.19	0.98	0.02	6.03E-02	1.87E-06	0.00E+00	6.03E-02
Nickel	12.1	0.0029	Equation	2.05	0.98	0.02	1.04E-01	2.52E-04	1.62E-04	1.05E-01
Selenium	2.9	0.000	1.00	2.90	0.98	0.02	1.47E-01	6.03E-05	0.00E+00	1.48E-01
Silver	3.1	0.000	0.18	0.56	0.98	0.02	2.84E-02	6.45E-05	0.00E+00	2.84E-02
Zinc	1720	0.498	Equation	198	0.98	0.02	1.01E+01	3.58E-02	2.79E-02	1.02E+01

COPECs	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	CTE** Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Diet: Invert Tissue Concentration ($C_{invert, dw}$)	Diet: DF_{Invert}	Diet: $Df_{sediment}$	Diet: $Dose_{invert}$ [1]	Sediment: $Dose_{sed}$ [2]	Water: $Dose_{water}$ [3]	Total EDD[4]
Arsenic	29.9	0.000	Equation	6.62	0.98	0.02	3.37E-01	6.22E-04	0.00E+00	3.37E-01
Cadmium	3.5	0.0010	Equation	0.92	0.98	0.02	4.69E-02	7.28E-05	5.60E-05	4.71E-02
Chromium	4.5	0.0058	Equation	2.80	0.98	0.02	1.43E-01	9.36E-05	3.25E-04	1.43E-01
Copper	177	0.0094	0.824	146	0.98	0.02	7.42E+00	3.68E-03	5.26E-04	7.42E+00
Lead	534	0.0055	Equation	18.5	0.98	0.02	9.39E-01	1.11E-02	3.08E-04	9.50E-01
Mercury	0.07	0.000	Equation	1.19	0.98	0.02	6.03E-02	1.46E-06	0.00E+00	6.03E-02
Nickel	10.0	0.0029	Equation	1.80	0.98	0.02	9.15E-02	2.08E-04	1.62E-04	9.19E-02
Selenium	2.9	0.000	1.00	2.90	0.98	0.02	1.47E-01	6.03E-05	0.00E+00	1.48E-01
Silver	2.0	0.000	0.18	0.36	0.98	0.02	1.83E-02	4.16E-05	0.00E+00	1.84E-02
Zinc	1114	0.265	Equation	188	0.98	0.02	9.56E+00	2.32E-02	1.48E-02	9.59E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} X C_{invert} X DF_{invert} X AUF$
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} X EPC_{sediment} X Df_{sed} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.51
EDDs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (100% benthic invertebrate diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kgbw-day)							CTE** Exposure Point Concentration		EDD (mg/kgbw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	27.0	0.000	0.61	0.98	0.02	3.12E-02	5.62E-04	0.00E+00	3.17E-02	19.4	0.000	0.61	0.98	0.02	3.12E-02	4.04E-04	0.00E+00	3.16E-02
Cadmium	6.4	0.0014	0.78	0.98	0.02	3.98E-02	1.33E-04	7.84E-05	4.00E-02	4.8	0.0010	0.78	0.98	0.02	3.98E-02	9.98E-05	5.60E-05	4.00E-02
Chromium	4.9	0.000	3.26	0.98	0.02	1.66E-01	1.02E-04	0.00E+00	1.66E-01	4.2	0.000	3.26	0.98	0.02	1.66E-01	8.74E-05	0.00E+00	1.66E-01
Copper	212	0.0197	15.1	0.98	0.02	7.66E-01	4.41E-03	1.10E-03	7.71E-01	147	0.0138	15.1	0.98	0.02	7.66E-01	3.06E-03	7.73E-04	7.69E-01
Lead	367	0.0231	2.3	0.98	0.02	1.17E-01	7.63E-03	1.29E-03	1.26E-01	300	0.0112	2.3	0.98	0.02	1.17E-01	6.24E-03	6.27E-04	1.24E-01
Mercury	0.04	0.000	0.25	0.98	0.02	1.25E-02	8.32E-07	0.00E+00	1.25E-02	0.04	0.000	0.25	0.98	0.02	1.25E-02	8.32E-07	0.00E+00	1.25E-02
Nickel	12.4	0.000	0.61	0.98	0.02	3.12E-02	2.58E-04	0.00E+00	3.14E-02	9.4	0.000	0.61	0.98	0.02	3.12E-02	1.96E-04	0.00E+00	3.14E-02
Selenium	1.4	0.000	1.22	0.98	0.02	6.23E-02	2.91E-05	0.00E+00	6.23E-02	1.2	0.000	1.22	0.98	0.02	6.23E-02	2.50E-05	0.00E+00	6.23E-02
Silver	1.4	0.000	0.61	0.98	0.02	3.12E-02	2.91E-05	0.00E+00	3.12E-02	1.1	0.000	0.61	0.98	0.02	3.12E-02	2.29E-05	0.00E+00	3.12E-02
Zinc	2778	0.503	187	0.98	0.02	9.52E+00	5.78E-02	2.82E-02	9.60E+00	1738	0.361	187	0.98	0.02	9.52E+00	3.62E-02	2.02E-02	9.57E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligramsper kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.52
Estimated daily doses for mallards foraging at sampling location A75B on the Animas R. below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	37.2	0.000	Equation	7.80	0.98	0.02	3.97E-01	7.74E-04	0.00E+00	3.98E-01	19.9	0.000	Equation	4.87	0.98	0.02	2.48E-01	4.14E-04	0.00E+00	2.48E-01
Cadmium	10.5	0.0011	Equation	1.62	0.98	0.02	8.25E-02	2.18E-04	6.16E-05	8.27E-02	5.0	0.0009	Equation	1.11	0.98	0.02	5.64E-02	1.04E-04	5.04E-05	5.65E-02
Chromium	5.5	0.000	Equation	3.02	0.98	0.02	1.53E-01	1.14E-04	0.00E+00	1.54E-01	5.2	0.000	Equation	2.95	0.98	0.02	1.50E-01	1.08E-04	0.00E+00	1.50E-01
Copper	413	0.0215	0.824	340	0.98	0.02	1.73E+01	8.59E-03	1.20E-03	1.73E+01	188	0.0122	0.824	155	0.98	0.02	7.88E+00	3.91E-03	6.83E-04	7.88E+00
Lead	435	0.0303	Equation	16.1	0.98	0.02	8.21E-01	9.05E-03	1.70E-03	8.32E-01	296	0.0121	Equation	12.6	0.98	0.02	6.38E-01	6.16E-03	6.78E-04	6.45E-01
Mercury	0.07	0.000	Equation	1.19	0.98	0.02	6.03E-02	1.46E-06	0.00E+00	6.03E-02	0.07	0.000	Equation	1.19	0.98	0.02	6.03E-02	1.46E-06	0.00E+00	6.03E-02
Nickel	16.5	0.000	Equation	2.55	0.98	0.02	1.30E-01	3.43E-04	0.00E+00	1.30E-01	9.7	0.000	Equation	1.76	0.98	0.02	8.96E-02	2.02E-04	0.00E+00	8.98E-02
Selenium	3.3	0.000	1.00	3.30	0.98	0.02	1.68E-01	6.86E-05	0.00E+00	1.68E-01	1.9	0.000	1.00	1.90	0.98	0.02	9.66E-02	3.95E-05	0.00E+00	9.67E-02
Silver	2.2	0.000	0.18	0.40	0.98	0.02	2.01E-02	4.58E-05	0.00E+00	2.02E-02	1.4	0.000	0.18	0.25	0.98	0.02	1.28E-02	2.91E-05	0.00E+00	1.28E-02
Zinc	5320	0.429	Equation	229	0.98	0.02	1.16E+01	1.11E-01	2.40E-02	1.18E+01	2190	0.302	Equation	205	0.98	0.02	1.04E+01	4.56E-02	1.69E-02	1.05E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
Where $C_{invert} = (EPC_{sediment} \times \text{Invert BSAF})$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.53
EDDs for mallards foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kgbw-day)							CTE** Exposure Point Concentration		EDD (mg/kg bw-day)						
			Diet				Sediment	Water				Diet				Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	29.7	0.000	0.23	0.98	0.02	1.17E-02	6.18E-04	0.00E+00	1.24E-02	21.9	0.000	0.23	0.98	0.02	1.17E-02	4.56E-04	0.00E+00	1.22E-02
Cadmium	18.6	0.0008	1.59	0.98	0.02	8.10E-02	3.87E-04	4.48E-05	8.14E-02	10.1	0.0007	1.59	0.98	0.02	8.10E-02	2.10E-04	3.92E-05	8.12E-02
Chromium	7.0	0.000	2.05	0.98	0.02	1.04E-01	1.46E-04	0.00E+00	1.04E-01	5.4	0.000	2.05	0.98	0.02	1.04E-01	1.12E-04	0.00E+00	1.04E-01
Copper	332	0.0138	17.6	0.98	0.02	8.94E-01	6.91E-03	7.73E-04	9.02E-01	191	0.0095	17.6	0.98	0.02	8.94E-01	3.97E-03	5.32E-04	8.99E-01
Lead	376	0.0177	2.5	0.98	0.02	1.29E-01	7.82E-03	9.91E-04	1.38E-01	300	0.0078	2.5	0.98	0.02	1.29E-01	6.24E-03	4.37E-04	1.36E-01
Mercury	0.06	0.000	0.09	0.98	0.02	4.73E-03	1.25E-06	0.00E+00	4.73E-03	0.04	0.000	0.09	0.98	0.02	4.73E-03	8.32E-07	0.00E+00	4.73E-03
Nickel	31.0	0.000	1.59	0.98	0.02	8.08E-02	6.45E-04	0.00E+00	8.14E-02	18.3	0.000	1.59	0.98	0.02	8.08E-02	3.81E-04	0.00E+00	8.11E-02
Selenium	3.1	0.000	0.47	0.98	0.02	2.37E-02	6.45E-05	0.00E+00	2.37E-02	2.1	0.000	0.47	0.98	0.02	2.37E-02	4.37E-05	0.00E+00	2.37E-02
Silver	1.7	0.000	0.23	0.98	0.02	1.17E-02	3.54E-05	0.00E+00	1.18E-02	1.3	0.000	0.23	0.98	0.02	1.17E-02	2.70E-05	0.00E+00	1.18E-02
Zinc	8544	0.272	353	0.98	0.02	1.80E+01	1.78E-01	1.52E-02	1.81E+01	4620	0.216	353	0.98	0.02	1.80E+01	9.61E-02	1.21E-02	1.81E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
* The RME value represents the 95% UCL or the maximum detected concentrationif a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.54
EDDs for the mallard foraging on the Animas River above Cement Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	RME* Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	Dose $_{plant}$ [2]	Sediment: Dose $_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Metals													
Arsenic	34.2	0.000	2.10	0.49	Equation	1.00	0.49	0.02	5.34E-02	2.54E-02	7.11E-04	0.00E+00	7.96E-02
Cadmium	12.9	0.0016	3.86	0.49	Equation	2.51	0.49	0.02	9.82E-02	6.38E-02	2.68E-04	8.96E-05	1.62E-01
Chromium	5.0	0.000	2.78	0.49	0.04	0.21	0.49	0.02	7.06E-02	5.21E-03	1.04E-04	0.00E+00	7.59E-02
Copper	399	0.0162	64.9	0.49	Equation	20.7	0.49	0.02	1.65E+00	5.26E-01	8.30E-03	9.07E-04	2.19E+00
Lead	1733	0.0219	25.2	0.49	Equation	17.4	0.49	0.02	6.41E-01	4.42E-01	3.60E-02	1.23E-03	1.12E+00
Mercury	0.10	0.000	0.09	0.49	Equation	0.11	0.49	0.02	2.24E-03	2.68E-03	2.08E-06	0.00E+00	4.92E-03
Nickel	9.2	0.000	0.52	0.49	Equation	0.57	0.49	0.02	1.31E-02	1.45E-02	1.91E-04	0.00E+00	2.78E-02
Selenium	1.0	0.000	0.88	0.49	Equation	0.51	0.49	0.02	2.24E-02	1.29E-02	2.08E-05	0.00E+00	3.53E-02
Silver	6.4	0.000	0.22	0.49	0.014	0.090	0.49	0.02	5.59E-03	2.28E-03	1.33E-04	0.00E+00	8.01E-03
Zinc	4054	0.488	799	0.49	Equation	486	0.49	0.02	2.03E+01	1.24E+01	8.43E-02	2.73E-02	3.28E+01

COPECs	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	CTE** Exposure Point Concentration: Surface Water (mg/L)	EDD (mg/kg bw-day) Diet: Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	Dose $_{plant}$ [2]	Sediment: Dose $_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.4	0.000	1.27	0.49	Equation	0.88	0.49	0.02	3.22E-02	2.24E-02	5.70E-04	0.00E+00	5.52E-02
Cadmium	11.1	0.0014	2.84	0.49	Equation	2.31	0.49	0.02	7.22E-02	5.88E-02	2.31E-04	7.84E-05	1.31E-01
Chromium	4.7	0.000	2.56	0.49	0.04	0.19	0.49	0.02	6.51E-02	4.90E-03	9.78E-05	0.00E+00	7.01E-02
Copper	339	0.0155	62.4	0.49	Equation	19.4	0.49	0.02	1.59E+00	4.93E-01	7.05E-03	8.68E-04	2.09E+00
Lead	1508	0.0116	21.3	0.49	Equation	16.1	0.49	0.02	5.43E-01	4.09E-01	3.14E-02	6.50E-04	9.84E-01
Mercury	0.07	0.000	0.09	0.49	Equation	0.09	0.49	0.02	2.16E-03	2.21E-03	1.46E-06	0.00E+00	4.37E-03
Nickel	8.2	0.000	0.52	0.49	Equation	0.52	0.49	0.02	1.31E-02	1.33E-02	1.71E-04	0.00E+00	2.66E-02
Selenium	1.5	0.000	0.88	0.49	Equation	0.79	0.49	0.02	2.24E-02	2.02E-02	3.12E-05	0.00E+00	4.27E-02
Silver	5.5	0.000	0.21	0.49	0.014	0.077	0.49	0.02	5.39E-03	1.96E-03	1.14E-04	0.00E+00	7.46E-03
Zinc	3172	0.432	579	0.49	Equation	424	0.49	0.02	1.47E+01	1.08E+01	6.60E-02	2.42E-02	2.56E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.55
EDDs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	Total EDD[5]
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{plant}$[2]	$Dose_{sed}$[3]	$Dose_{water}$[4]	
Arsenic	39.6	0.0050	0.27	0.49	Equation	1.09	0.49	0.02	6.76E-03	2.76E-02	8.24E-04	2.80E-04	3.55E-02
Cadmium	2.9	0.0019	0.68	0.49	Equation	1.11	0.49	0.02	1.73E-02	2.83E-02	6.03E-05	1.06E-04	4.57E-02
Chromium	6.1	0.000	2.16	0.49	0.04	0.25	0.49	0.02	5.50E-02	6.36E-03	1.27E-04	0.00E+00	6.14E-02
Copper	173	0.0307	38	0.49	Equation	14.9	0.49	0.02	9.74E-01	3.78E-01	3.60E-03	1.72E-03	1.36E+00
Lead	581	0.0305	7.6	0.49	Equation	9.4	0.49	0.02	1.92E-01	2.40E-01	1.21E-02	1.71E-03	4.46E-01
Mercury	0.070	0.000	0.11	0.49	Equation	0.09	0.49	0.02	2.72E-03	2.21E-03	1.46E-06	0.00E+00	4.93E-03
Nickel	5.9	0.0037	0.27	0.49	Equation	0.41	0.49	0.02	6.76E-03	1.04E-02	1.23E-04	2.07E-04	1.75E-02
Selenium	1.9	0.000	0.53	0.49	Equation	1.03	0.49	0.02	1.36E-02	2.62E-02	3.95E-05	0.00E+00	3.98E-02
Silver	2.4	0.000	0.27	0.49	0.014	0.034	0.49	0.02	6.76E-03	8.54E-04	4.99E-05	0.00E+00	7.67E-03
Zinc	819	0.711	166	0.49	Equation	200	0.49	0.02	4.23E+00	5.08E+00	1.70E-02	3.98E-02	9.37E+00

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	Total EDD[5]
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration ($C_{plant, dw}$)	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$[1]	$Dose_{plant}$[2]	$Dose_{sed}$[3]	$Dose_{water}$[4]	
Arsenic	33.4	0.0050	0.27	0.49	Equation	0.99	0.49	0.02	6.76E-03	2.51E-02	6.95E-04	2.80E-04	3.28E-02
Cadmium	2.1	0.0016	0.68	0.49	Equation	0.93	0.49	0.02	1.73E-02	2.37E-02	4.37E-05	8.96E-05	4.11E-02
Chromium	4.6	0.000	2.16	0.49	0.04	0.19	0.49	0.02	5.50E-02	4.80E-03	9.57E-05	0.00E+00	5.98E-02
Copper	137	0.0274	38	0.49	Equation	13.6	0.49	0.02	9.74E-01	3.45E-01	2.85E-03	1.53E-03	1.32E+00
Lead	478	0.0128	7.6	0.49	Equation	8.4	0.49	0.02	1.92E-01	2.15E-01	9.94E-03	7.17E-04	4.18E-01
Mercury	0.06	0.000	0.11	0.49	Equation	0.08	0.49	0.02	2.72E-03	2.03E-03	1.25E-06	0.00E+00	4.76E-03
Nickel	5.1	0.0050	0.27	0.49	Equation	0.37	0.49	0.02	6.76E-03	9.31E-03	1.06E-04	2.80E-04	1.65E-02
Selenium	1.5	0.000	0.53	0.49	Equation	0.79	0.49	0.02	1.36E-02	2.02E-02	3.12E-05	0.00E+00	3.38E-02
Silver	1.9	0.000	0.27	0.49	0.014	0.027	0.49	0.02	6.76E-03	6.76E-04	3.95E-05	0.00E+00	7.48E-03
Zinc	651	0.600	166	0.49	Equation	176	0.49	0.02	4.23E+00	4.48E+00	1.35E-02	3.36E-02	8.75E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times \text{plant BSAF})$ or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0519
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.056
$\mathbf{IR_{sediment}}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: 3/3/15

Table 4.56
EDDs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	33.8	0.000	0.69	0.49	Equation	0.99	0.49	0.02	1.76E-02	2.53E-02	7.03E-04	0.00E+00	4.36E-02
Cadmium	5.4	0.0021	0.94	0.49	Equation	1.56	0.49	0.02	2.38E-02	3.97E-02	1.12E-04	1.18E-04	6.37E-02
Chromium	5.4	0.000	2.03	0.49	0.04	0.22	0.49	0.02	5.17E-02	5.63E-03	1.12E-04	0.00E+00	5.74E-02
Copper	284	0.0228	33	0.49	Equation	18.1	0.49	0.02	8.45E-01	4.60E-01	5.91E-03	1.28E-03	1.31E+00
Lead	729	0.0234	6.7	0.49	Equation	10.7	0.49	0.02	1.71E-01	2.72E-01	1.52E-02	1.31E-03	4.60E-01
Mercury	0.05	0.000	0.11	0.49	Equation	0.07	0.49	0.02	2.80E-03	1.84E-03	1.04E-06	0.00E+00	4.64E-03
Nickel	7.2	0.0038	0.58	0.49	Equation	0.47	0.49	0.02	1.46E-02	1.20E-02	1.50E-04	2.13E-04	2.71E-02
Selenium	1.4	0.000	0.55	0.49	Equation	0.74	0.49	0.02	1.40E-02	1.87E-02	2.91E-05	0.00E+00	3.27E-02
Silver	2.8	0.000	0.28	0.49	0.014	0.039	0.49	0.02	6.99E-03	9.97E-04	5.82E-05	0.00E+00	8.05E-03
Zinc	1393	0.704	197	0.49	Equation	268	0.49	0.02	5.02E+00	6.83E+00	2.90E-02	3.94E-02	1.19E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.9	0.000	0.69	0.49	Equation	0.89	0.49	0.02	1.76E-02	2.27E-02	5.80E-04	0.00E+00	4.09E-02
Cadmium	4.0	0.0015	0.94	0.49	Equation	1.32	0.49	0.02	2.38E-02	3.37E-02	8.32E-05	8.40E-05	5.76E-02
Chromium	4.0	0.000	2.03	0.49	0.04	0.16	0.49	0.02	5.17E-02	4.17E-03	8.32E-05	0.00E+00	5.59E-02
Copper	199	0.0178	33	0.49	Equation	15.7	0.49	0.02	8.45E-01	4.00E-01	4.14E-03	9.97E-04	1.25E+00
Lead	513	0.0111	6.7	0.49	Equation	8.8	0.49	0.02	1.71E-01	2.23E-01	1.07E-02	6.22E-04	4.06E-01
Mercury	0.04	0.000	0.11	0.49	Equation	0.06	0.49	0.02	2.80E-03	1.63E-03	8.32E-07	0.00E+00	4.43E-03
Nickel	6.4	0.0038	0.58	0.49	Equation	0.43	0.49	0.02	1.46E-02	1.10E-02	1.33E-04	2.13E-04	2.60E-02
Selenium	1.1	0.000	0.55	0.49	Equation	0.56	0.49	0.02	1.40E-02	1.43E-02	2.29E-05	0.00E+00	2.83E-02
Silver	1.9	0.000	0.28	0.49	0.014	0.027	0.49	0.02	6.99E-03	6.76E-04	3.95E-05	0.00E+00	7.71E-03
Zinc	1049	0.521	197	0.49	Equation	229	0.49	0.02	5.02E+00	5.83E+00	2.18E-02	2.92E-02	1.09E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$

2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$

Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation

3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$

4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$

5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.57
EDDs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment: $Dose_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Arsenic	39.4	0.000	Equation	8.15	0.49	Equation	1.08	0.49	0.02	2.07E-01	2.75E-02	8.20E-04	0.00E+00	2.36E-01
Cadmium	4.2	0.0015	Equation	1.01	0.49	Equation	1.36	0.49	0.02	2.58E-02	3.46E-02	8.74E-05	8.40E-05	6.05E-02
Chromium	5.0	0.0058	Equation	2.91	0.49	0.04	0.21	0.49	0.02	7.41E-02	5.21E-03	1.04E-04	3.25E-04	7.97E-02
Copper	292	0.0131	0.824	241	0.49	Equation	18.3	0.49	0.02	6.12E+00	4.65E-01	6.07E-03	7.34E-04	6.59E+00
Lead	593	0.0106	Equation	19.8	0.49	Equation	9.5	0.49	0.02	5.03E-01	2.42E-01	1.23E-02	5.94E-04	7.58E-01
Mercury	0.09	0.000	Equation	1.19	0.49	Equation	0.10	0.49	0.02	3.02E-02	2.53E-03	1.87E-06	0.00E+00	3.27E-02
Nickel	12.1	0.0029	Equation	2.05	0.49	Equation	0.70	0.49	0.02	5.22E-02	1.78E-02	2.52E-04	1.62E-04	7.04E-02
Selenium	2.9	0.000	1.00	2.90	0.49	Equation	1.64	0.49	0.02	7.37E-02	4.18E-02	6.03E-05	0.00E+00	1.16E-01
Silver	3.1	0.000	0.18	0.56	0.49	0.014	0.043	0.49	0.02	1.42E-02	1.10E-03	6.45E-05	0.00E+00	1.54E-02
Zinc	1720	0.498	Equation	198	0.49	Equation	302	0.49	0.02	5.05E+00	7.68E+00	3.58E-02	2.79E-02	1.28E+01

COPECs	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment: $Dose_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Arsenic	29.9	0.000	Equation	6.62	0.49	Equation	0.93	0.49	0.02	1.68E-01	2.36E-02	6.22E-04	0.00E+00	1.92E-01
Cadmium	3.5	0.0010	Equation	0.92	0.49	Equation	1.23	0.49	0.02	2.35E-02	3.13E-02	7.28E-05	5.60E-05	5.49E-02
Chromium	4.5	0.0058	Equation	2.80	0.49	0.04	0.18	0.49	0.02	7.13E-02	4.69E-03	9.36E-05	3.25E-04	7.64E-02
Copper	177	0.0094	0.824	146	0.49	Equation	15.0	0.49	0.02	3.71E+00	3.82E-01	3.68E-03	5.26E-04	4.09E+00
Lead	534	0.0055	Equation	18.5	0.49	Equation	9.0	0.49	0.02	4.69E-01	2.28E-01	1.11E-02	3.08E-04	7.09E-01
Mercury	0.07	0.000	Equation	1.19	0.49	Equation	0.09	0.49	0.02	3.02E-02	2.21E-03	1.46E-06	0.00E+00	3.24E-02
Nickel	10.0	0.0029	Equation	1.80	0.49	Equation	0.61	0.49	0.02	4.57E-02	1.54E-02	2.08E-04	1.62E-04	6.15E-02
Selenium	2.9	0.000	1.00	2.90	0.49	Equation	1.64	0.49	0.02	7.37E-02	4.18E-02	6.03E-05	0.00E+00	1.16E-01
Silver	2.0	0.000	0.18	0.36	0.49	0.014	0.028	0.49	0.02	9.16E-03	7.12E-04	4.16E-05	0.00E+00	9.91E-03
Zinc	1114	0.265	Equation	188	0.49	Equation	237	0.49	0.02	4.78E+00	6.03E+00	2.32E-02	1.48E-02	1.08E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.58
EDDs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	27.0	0.000	0.61	0.49	Equation	0.88	0.49	0.02	1.56E-02	2.23E-02	5.62E-04	0.00E+00	3.84E-02
Cadmium	6.4	0.0014	0.78	0.49	Equation	1.71	0.49	0.02	1.99E-02	4.35E-02	1.33E-04	7.84E-05	6.37E-02
Chromium	4.9	0.000	3.26	0.49	0.04	0.20	0.49	0.02	8.28E-02	5.11E-03	1.02E-04	0.00E+00	8.80E-02
Copper	212	0.0197	15.1	0.49	Equation	16.1	0.49	0.02	3.83E-01	4.10E-01	4.41E-03	1.10E-03	7.98E-01
Lead	367	0.0231	2.3	0.49	Equation	7.3	0.49	0.02	5.83E-02	1.85E-01	7.63E-03	1.29E-03	2.52E-01
Mercury	0.04	0.000	0.25	0.49	Equation	0.06	0.49	0.02	6.23E-03	1.63E-03	8.32E-07	0.00E+00	7.86E-03
Nickel	12.4	0.000	0.61	0.49	Equation	0.71	0.49	0.02	1.56E-02	1.81E-02	2.58E-04	0.00E+00	3.39E-02
Selenium	1.4	0.000	1.22	0.49	Equation	0.74	0.49	0.02	3.11E-02	1.87E-02	2.91E-05	0.00E+00	4.99E-02
Silver	1.4	0.000	0.61	0.49	0.014	0.020	0.49	0.02	1.56E-02	4.98E-04	2.91E-05	0.00E+00	1.61E-02
Zinc	2778	0.503	187	0.49	Equation	394	0.49	0.02	4.76E+00	1.00E+01	5.78E-02	2.82E-02	1.49E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)										
			Diet								Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	$Dose_{sed}$ [3]	$Dose_{water}$ [4]	Total EDD[5]
Arsenic	19.4	0.000	0.61	0.49	Equation	0.73	0.49	0.02	1.56E-02	1.85E-02	4.04E-04	0.00E+00	3.45E-02
Cadmium	4.8	0.0010	0.78	0.49	Equation	1.46	0.49	0.02	1.99E-02	3.72E-02	9.98E-05	5.60E-05	5.73E-02
Chromium	4.2	0.000	3.26	0.49	0.04	0.17	0.49	0.02	8.28E-02	4.38E-03	8.74E-05	0.00E+00	8.73E-02
Copper	147	0.0138	15.1	0.49	Equation	13.9	0.49	0.02	3.83E-01	3.55E-01	3.06E-03	7.73E-04	7.41E-01
Lead	300	0.0112	2.3	0.49	Equation	6.5	0.49	0.02	5.83E-02	1.65E-01	6.24E-03	6.27E-04	2.31E-01
Mercury	0.04	0.000	0.25	0.49	Equation	0.06	0.49	0.02	6.23E-03	1.63E-03	8.32E-07	0.00E+00	7.86E-03
Nickel	9.4	0.000	0.61	0.49	Equation	0.58	0.49	0.02	1.56E-02	1.47E-02	1.96E-04	0.00E+00	3.05E-02
Selenium	1.2	0.000	1.22	0.49	Equation	0.62	0.49	0.02	3.11E-02	1.58E-02	2.50E-05	0.00E+00	4.69E-02
Silver	1.1	0.000	0.61	0.49	0.014	0.015	0.49	0.02	1.56E-02	3.92E-04	2.29E-05	0.00E+00	1.60E-02
Zinc	1738	0.361	187	0.49	Equation	304	0.49	0.02	4.76E+00	7.72E+00	3.62E-02	2.02E-02	1.25E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times \text{plant BSAF})$ or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total $EDD = Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.59
EDDs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	RME* Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment: $Dose_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Arsenic	37.2	0.000	Equation	7.80	0.49	Equation	1.05	0.49	0.02	1.98E-01	2.67E-02	7.74E-04	0.00E+00	2.26E-01
Cadmium	10.5	0.0011	Equation	1.62	0.49	Equation	2.24	0.49	0.02	4.12E-02	5.70E-02	2.18E-04	6.16E-05	9.86E-02
Chromium	5.5	0.000	Equation	3.02	0.49	0.04	0.23	0.49	0.02	7.67E-02	5.73E-03	1.14E-04	0.00E+00	8.25E-02
Copper	413	0.0215	0.824	340	0.49	Equation	21.0	0.49	0.02	8.65E+00	5.33E-01	8.59E-03	1.20E-03	9.20E+00
Lead	435	0.0303	Equation	16.1	0.49	Equation	8.0	0.49	0.02	4.10E-01	2.04E-01	9.05E-03	1.70E-03	6.25E-01
Mercury	0.07	0.000	Equation	1.19	0.49	Equation	0.09	0.49	0.02	3.02E-02	2.21E-03	1.46E-06	0.00E+00	3.24E-02
Nickel	16.5	0.000	Equation	2.55	0.49	Equation	0.88	0.49	0.02	6.48E-02	2.24E-02	3.43E-04	0.00E+00	8.75E-02
Selenium	3.3	0.000	1.00	3.30	0.49	Equation	1.90	0.49	0.02	8.39E-02	4.82E-02	6.86E-05	0.00E+00	1.32E-01
Silver	2.2	0.000	0.18	0.40	0.49	0.014	0.031	0.49	0.02	1.01E-02	7.83E-04	4.58E-05	0.00E+00	1.09E-02
Zinc	5320	0.429	Equation	229	0.49	Equation	565	0.49	0.02	5.82E+00	1.44E+01	1.11E-01	2.40E-02	2.03E+01

COPECs	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	CTE** Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BSAFs	Invert Tissue Concentration ($C_{invert, dw}$)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment: $Dose_{sed}$ [3]	Water: $Dose_{water}$ [4]	Total EDD[5]
Arsenic	19.9	0.000	Equation	4.87	0.49	Equation	0.74	0.49	0.02	1.24E-01	1.87E-02	4.14E-04	0.00E+00	1.43E-01
Cadmium	5.0	0.0009	Equation	1.11	0.49	Equation	1.50	0.49	0.02	2.82E-02	3.80E-02	1.04E-04	5.04E-05	6.64E-02
Chromium	5.2	0.000	Equation	2.95	0.49	0.04	0.21	0.49	0.02	7.51E-02	5.42E-03	1.08E-04	0.00E+00	8.07E-02
Copper	188	0.0122	0.824	155	0.49	Equation	15.4	0.49	0.02	3.94E+00	3.91E-01	3.91E-03	6.83E-04	4.33E+00
Lead	296	0.0121	Equation	12.6	0.49	Equation	6.5	0.49	0.02	3.19E-01	1.64E-01	6.16E-03	6.78E-04	4.90E-01
Mercury	0.07	0.000	Equation	1.19	0.49	Equation	0.09	0.49	0.02	3.02E-02	2.21E-03	1.46E-06	0.00E+00	3.24E-02
Nickel	9.7	0.000	Equation	1.76	0.49	Equation	0.59	0.49	0.02	4.48E-02	1.51E-02	2.02E-04	0.00E+00	6.00E-02
Selenium	1.9	0.000	1.00	1.90	0.49	Equation	1.03	0.49	0.02	4.83E-02	2.62E-02	3.95E-05	0.00E+00	7.46E-02
Silver	1.4	0.000	0.18	0.25	0.49	0.014	0.020	0.49	0.02	6.41E-03	4.98E-04	2.91E-05	0.00E+00	6.94E-03
Zinc	2190	0.302	Equation	205	0.49	Equation	345	0.49	0.02	5.20E+00	8.78E+00	4.56E-02	1.69E-02	1.40E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
Where C_{invert} = ($EPC_{sediment}$ X Invert BSAF) or the result of the BSAF regression equation
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.60
EDDs for mallards foraging at the Bakers Bridge sampling location on the Animas R. below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration Sediment (mg/kg, dw)	RME* Exposure Point Concentration Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment $Dose_{sed}$ [3]	Water $Dose_{water}$ [4]	Total EDD[5]
Arsenic	29.7	0	0.23	0.49	Equation	0.92	0.49	0.02	5.87E-03	2.35E-02	6.18E-04	0.00E+00	3.00E-02
Cadmium	18.6	0.0008	1.59	0.49	Equation	3.06	0.49	0.02	4.05E-02	7.79E-02	3.87E-04	4.48E-05	1.19E-01
Chromium	7.0	0	2.05	0.49	0.04	0.29	0.49	0.02	5.21E-02	7.30E-03	1.46E-04	0.00E+00	5.95E-02
Copper	332	0.0138	17.6	0.49	Equation	19.2	0.49	0.02	4.47E-01	4.89E-01	6.91E-03	7.73E-04	9.44E-01
Lead	376	0.0177	2.5	0.49	Equation	7.4	0.49	0.02	6.44E-02	1.88E-01	7.82E-03	9.91E-04	2.61E-01
Mercury	0.06	0	0.09	0.49	Equation	0.08	0.49	0.02	2.37E-03	2.03E-03	1.25E-06	0.00E+00	4.40E-03
Nickel	31.0	0	1.59	0.49	Equation	1.41	0.49	0.02	4.04E-02	3.59E-02	6.45E-04	0.00E+00	7.69E-02
Selenium	3.1	0	0.47	0.49	Equation	1.77	0.49	0.02	1.18E-02	4.50E-02	6.45E-05	0.00E+00	5.69E-02
Silver	1.7	0	0.23	0.49	0.014	0.024	0.49	0.02	5.87E-03	6.05E-04	3.54E-05	0.00E+00	6.52E-03
Zinc	8544	0.272	353	0.49	Equation	735	0.49	0.02	8.98E+00	1.87E+01	1.78E-01	1.52E-02	2.79E+01

COPECs	CTE** Exposure Point Concentration Sediment (mg/kg, dw)	CTE** Exposure Point Concentration Surface Water (ug/L)	Invert Tissue Concentration (dw)	DF_{Invert}	Plant BSAFs	Plant Concentration (C_{plant})	Df_{plant}	$Df_{sediment}$	$Dose_{invert}$ [1]	$Dose_{plant}$ [2]	Sediment $Dose_{sed}$ [3]	Water $Dose_{water}$ [4]	Total EDD[5]
Arsenic	21.9	0	0.23	0.49	Equation	0.78	0.49	0.02	5.87E-03	1.98E-02	4.56E-04	0.00E+00	2.61E-02
Cadmium	10.1	0.0007	1.59	0.49	Equation	2.20	0.49	0.02	4.05E-02	5.58E-02	2.10E-04	3.92E-05	9.66E-02
Chromium	5.4	0	2.05	0.49	0.04	0.22	0.49	0.02	5.21E-02	5.63E-03	1.12E-04	0.00E+00	5.78E-02
Copper	191	0.0095	17.6	0.49	Equation	15.5	0.49	0.02	4.47E-01	3.93E-01	3.97E-03	5.32E-04	8.45E-01
Lead	300	0.0078	2.5	0.49	Equation	6.5	0.49	0.02	6.44E-02	1.65E-01	6.24E-03	4.37E-04	2.36E-01
Mercury	0.04	0	0.09	0.49	Equation	0.06	0.49	0.02	2.37E-03	1.63E-03	8.32E-07	0.00E+00	4.00E-03
Nickel	18.3	0	1.59	0.49	Equation	0.95	0.49	0.02	4.04E-02	2.42E-02	3.81E-04	0.00E+00	6.50E-02
Selenium	2.1	0	0.47	0.49	Equation	1.15	0.49	0.02	1.18E-02	2.93E-02	4.37E-05	0.00E+00	4.12E-02
Silver	1.3	0	0.23	0.49	0.014	0.018	0.49	0.02	5.87E-03	4.63E-04	2.70E-05	0.00E+00	6.36E-03
Zinc	4620	0.216	353	0.49	Equation	522	0.49	0.02	8.98E+00	1.33E+01	9.61E-02	1.21E-02	2.24E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{invert} = IR_{diet} \times C_{invert} \times DF_{invert} \times AUF$
2 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{plant} \times AUF$
Where C_{plant} = ($EPC_{sediment}$ X plant BSAF) or the result of the BSAF regression equation
3 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
4 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
5 Total EDD = $Dose_{invert} + Dose_{plant} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.162
IR_{diet} (kg/kg BW-day, dw)	0.0519
IR_{water} (L/kg BW-day)	0.056
$IR_{sediment}$ (kg/kg DW-day,dw)	0.00104

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 4.61
EDDs for the belted kingfisher foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	34.2	0.000	0.126	4.31	0.98	0.02	3.67E-01	1.19E-03	0.00E+00	3.68E-01
Cadmium	12.9	0.0016	0.164	2.12	0.98	0.02	1.80E-01	4.48E-04	1.78E-04	1.81E-01
Chromium	5.0	0.000	0.038	0.19	0.98	0.02	1.62E-02	1.74E-04	0.00E+00	1.64E-02
Copper	399	0.0162	0.100	39.9	0.98	0.02	3.40E+00	1.39E-02	1.80E-03	3.41E+00
Lead	1733	0.0219	0.070	121	0.98	0.02	1.03E+01	6.02E-02	2.43E-03	1.04E+01
Mercury (inorganic)	0.10	0.000	3.25	0.325	0.98	0.02	2.77E-02	3.48E-06	0.00E+00	2.77E-02
Nickel	9.2	0.000	1.00	9.2	0.98	0.02	7.83E-01	3.20E-04	0.00E+00	7.84E-01
Selenium	1.0	0.000	1.00	1.00	0.98	0.02	8.50E-02	3.47E-05	0.00E+00	8.50E-02
Silver	6.4	0.000	1.00	6.40	0.98	0.02	5.45E-01	2.22E-04	0.00E+00	5.45E-01
Zinc	4054	0.488	0.147	596	0.98	0.02	5.08E+01	1.41E-01	5.42E-02	5.09E+01

COPECs	CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{Fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	27.4	0.000	0.126	3.45	0.98	0.02	2.94E-01	9.52E-04	0.00E+00	2.95E-01
Cadmium	11.1	0.0014	0.164	1.82	0.98	0.02	1.55E-01	3.86E-04	1.55E-04	1.56E-01
Chromium	4.7	0.000	0.220	1.03	0.98	0.02	8.81E-02	1.63E-04	0.00E+00	8.82E-02
Copper	339	0.0155	0.100	33.9	0.98	0.02	2.89E+00	1.18E-02	1.72E-03	2.90E+00
Lead	1508	0.0116	0.070	106	0.98	0.02	8.99E+00	5.24E-02	1.29E-03	9.04E+00
Mercury (inorganic)	0.07	0.000	0.13	0.009	0.98	0.02	7.75E-04	2.43E-06	0.00E+00	7.77E-04
Nickel	8.2	0.000	4.58	37.6	0.98	0.02	3.20E+00	2.85E-04	0.00E+00	3.20E+00
Selenium	1.5	0.000	1.00	1.500	0.98	0.02	1.28E-01	5.21E-05	0.00E+00	1.28E-01
Silver	5.5	0.000	1.00	5.50	0.98	0.02	4.68E-01	1.91E-04	0.00E+00	4.69E-01
Zinc	3172	0.432	0.147	466	0.98	0.02	3.97E+01	1.10E-01	4.80E-02	3.99E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{fish} = (IR_{diet} \times C_{fish} \times DF_{fish} \times AUF)$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = (IR_{sediment} \times EPC_{sediment} \times DF_{sediment} \times AUF)$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 $Total\ EDD = Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 4.62
EDDs for the belted kingfisher foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish,\,dw}$)	DF_{fish}	DF $_{sediment}$	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish,\,dw}$)	DF_{Fish}	DF $_{sediment}$	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.6	0.0050	0.126	4.99	0.98	0.02	4.25E-01	1.38E-03	5.55E-04	4.27E-01	33.4	0.0050	0.126	4.21	0.98	0.02	3.58E-01	1.16E-03	5.55E-04	3.60E-01
Cadmium	2.9	0.002	0.164	0.48	0.98	0.02	4.05E-02	1.01E-04	2.11E-04	4.08E-02	2.1	0.0016	0.164	0.34	0.98	0.02	2.93E-02	7.30E-05	1.78E-04	2.96E-02
Chromium	6.1	0.000	0.038	0.23	0.98	0.02	1.97E-02	2.12E-04	0.00E+00	2.00E-02	4.6	0.000	0.038	0.17	0.98	0.02	1.49E-02	1.60E-04	0.00E+00	1.50E-02
Copper	173	0.0307	0.100	17.3	0.98	0.02	1.47E+00	6.01E-03	3.41E-03	1.48E+00	137	0.0274	0.100	13.7	0.98	0.02	1.17E+00	4.76E-03	3.04E-03	1.17E+00
Lead	581	0.0305	0.070	41	0.98	0.02	3.46E+00	2.02E-02	3.39E-03	3.49E+00	478	0.0128	0.070	33	0.98	0.02	2.85E+00	1.66E-02	1.42E-03	2.87E+00
Mercury (inorganic)	0.070	0.000	3.25	0.228	0.98	0.02	1.94E-02	2.43E-06	0.00E+00	1.94E-02	0.06	0.000	3.25	0.195	0.98	0.02	1.66E-02	2.09E-06	0.00E+00	1.66E-02
Nickel	5.9	0.0037	1.00	5.9	0.98	0.02	5.02E-01	2.05E-04	4.11E-04	5.03E-01	5.1	0.0050	1.00	5.1	0.98	0.02	4.34E-01	1.77E-04	5.55E-04	4.35E-01
Selenium	1.9	0.000	1.00	1.90	0.98	0.02	1.62E-01	6.60E-05	0.00E+00	1.62E-01	1.5	0.000	1.00	1.500	0.98	0.02	1.28E-01	5.21E-05	0.00E+00	1.28E-01
Silver	2.4	0.000	1.00	2.40	0.98	0.02	2.04E-01	8.34E-05	0.00E+00	2.04E-01	1.9	0.000	1.00	1.90	0.98	0.02	1.62E-01	6.60E-05	0.00E+00	1.62E-01
Zinc	819	0.711	0.147	120	0.98	0.02	1.03E+01	2.85E-02	7.89E-02	1.04E+01	651	0.600	0.147	96	0.98	0.02	8.15E+00	2.26E-02	6.66E-02	8.24E+00

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{fish} = (IR_{diet} X\ C_{fish} X\ DF_{fish} X\ AUF)$
Where $C_{fish} = EPC_{sediment} X\ BSAF$
2 $Dose_{sediment} = (IR_{sediment} X\ EPC_{sediment} X\ DF_{sediment} X\ AUF)$
3 $Dose_{water} = IR_{water} X\ C_{water} X\ AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0869
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.63
EDDs for the belted kingfisher foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	DF sediment	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{Fish}	DF sediment	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	33.8	0.000	0.126	4.26	0.98	0.02	3.63E-01	1.17E-03	0.00E+00	3.64E-01	27.9	0.000	0.126	3.52	0.98	0.02	2.99E-01	9.70E-04	0.00E+00	3.00E-01
Cadmium	5.4	0.0021	0.164	0.89	0.98	0.02	7.54E-02	1.88E-04	2.33E-04	7.58E-02	4.0	0.0015	0.164	0.66	0.98	0.02	5.59E-02	1.39E-04	1.67E-04	5.62E-02
Chromium	5.4	0.000	0.038	0.21	0.98	0.02	1.75E-02	1.88E-04	0.00E+00	1.77E-02	4.0	0.000	0.038	0.15	0.98	0.02	1.29E-02	1.39E-04	0.00E+00	1.31E-02
Copper	284	0.0228	0.100	28.4	0.98	0.02	2.42E+00	9.87E-03	2.53E-03	2.43E+00	199	0.0178	0.100	19.9	0.98	0.02	1.69E+00	6.92E-03	1.98E-03	1.70E+00
Lead	729	0.0234	0.070	51	0.98	0.02	4.35E+00	2.53E-02	2.60E-03	4.37E+00	513	0.0111	0.070	36	0.98	0.02	3.06E+00	1.78E-02	1.23E-03	3.08E+00
Mercury (inorganic)	0.05	0.000	3.25	0.163	0.98	0.02	1.38E-02	1.74E-06	0.00E+00	1.38E-02	0.04	0.000	3.25	0.130	0.98	0.02	1.11E-02	1.39E-06	0.00E+00	1.11E-02
Nickel	7.2	0.0038	1.00	7.2	0.98	0.02	6.13E-01	2.50E-04	4.22E-04	6.14E-01	6.4	0.0038	1.00	6.4	0.98	0.02	5.45E-01	2.22E-04	4.22E-04	5.46E-01
Selenium	1.4	0.000	1.00	1.40	0.98	0.02	1.19E-01	4.87E-05	0.00E+00	1.19E-01	1.1	0.000	1.00	1.100	0.98	0.02	9.37E-02	3.82E-05	0.00E+00	9.37E-02
Silver	2.8	0.000	1.00	2.80	0.98	0.02	2.38E-01	9.73E-05	0.00E+00	2.39E-01	1.9	0.000	1.00	1.90	0.98	0.02	1.62E-01	6.60E-05	0.00E+00	1.62E-01
Zinc	1393	0.704	0.147	205	0.98	0.02	1.74E+01	4.84E-02	7.81E-02	1.76E+01	1049	0.521	0.147	154	0.98	0.02	1.31E+01	3.65E-02	5.78E-02	1.32E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dosef_{fish} = (IR_{diet} \text{ X } C_{fish} \text{ X } DF_{fish} \text{ X AUF})$
Where $C_{fish} = EPC_{sediment} \text{ X BSAF}$
2 $Dose_{sediment} = (IR_{sediment} \text{ X } EPC_{sediment} \text{ X } DF_{sediment} \text{ X AUF})$
3 $Dose_{water} = IR_{water} \text{ X } C_{water} \text{ X AUF}$
4 $\text{Total EDD} = Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.64
EDDs for the belted kingfisher foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	$DF_{sediment}$	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	DF sediment	$Dose_{fish}$ [1]	$Dose_{sediment}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.4	0.000	0.126	4.96	0.98	0.02	4.23E-01	1.37E-03	0.00E+00	4.24E-01	29.9	0.000	0.126	3.77	0.98	0.02	3.21E-01	1.04E-03	0.00E+00	3.22E-01
Cadmium	4.2	0.0015	0.164	0.69	0.98	0.02	5.87E-02	1.46E-04	1.67E-04	5.90E-02	3.5	0.0010	0.164	0.57	0.98	0.02	4.89E-02	1.22E-04	1.11E-04	4.91E-02
Chromium	5.0	0.0058	0.038	0.19	0.98	0.02	1.62E-02	1.74E-04	6.44E-04	1.70E-02	4.5	0.0058	0.038	0.17	0.98	0.02	1.46E-02	1.56E-04	6.44E-04	1.54E-02
Copper	292	0.0131	0.100	29.2	0.98	0.02	2.49E+00	1.01E-02	1.45E-03	2.50E+00	177	0.0094	0.100	17.7	0.98	0.02	1.51E+00	6.15E-03	1.04E-03	1.51E+00
Lead	593	0.0106	0.070	42	0.98	0.02	3.54E+00	2.06E-02	1.18E-03	3.56E+00	534	0.0055	0.070	37	0.98	0.02	3.18E+00	1.86E-02	6.11E-04	3.20E+00
Mercury (inorganic)	0.09	0.000	3.25	0.293	0.98	0.02	2.49E-02	3.13E-06	0.00E+00	2.49E-02	0.07	0.000	3.25	0.228	0.98	0.02	1.94E-02	2.43E-06	0.00E+00	1.94E-02
Nickel	12.1	0.0029	1.00	12.1	0.98	0.02	1.03E+00	4.21E-04	3.22E-04	1.03E+00	10.0	0.0029	1.00	10.0	0.98	0.02	8.52E-01	3.48E-04	3.22E-04	8.52E-01
Selenium	2.9	0.000	1.00	2.90	0.98	0.02	2.47E-01	1.01E-04	0.00E+00	2.47E-01	2.9	0.000	1.00	2.900	0.98	0.02	2.47E-01	1.01E-04	0.00E+00	2.47E-01
Silver	3.1	0.000	1.00	3.10	0.98	0.02	2.64E-01	1.08E-04	0.00E+00	2.64E-01	2.0	0.000	1.00	2.00	0.98	0.02	1.70E-01	6.95E-05	0.00E+00	1.70E-01
Zinc	1720	0.498	0.147	253	0.98	0.02	2.15E+01	5.98E-02	5.53E-02	2.16E+01	1114	0.265	0.147	164	0.98	0.02	1.39E+01	3.87E-02	2.94E-02	1.40E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{fish} = (IR_{diet} \times C_{fish} \times DF_{fish} \times AUF)$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = (IR_{sediment} \times EPC_{sediment} \times DF_{sediment} \times AUF)$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD $= Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.65
EDDs for the belted kingfisher foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{Fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	27.0	0.000	0.126	3.40	0.98	0.02	2.90E-01	9.39E-04	0.00E+00	2.91E-01	19.4	0.000	0.126	2.44	0.98	0.02	2.08E-01	6.74E-04	0.00E+00	2.09E-01
Cadmium	6.4	0.0014	0.164	1.05	0.98	0.02	8.94E-02	2.22E-04	1.55E-04	8.98E-02	4.8	0.0010	0.164	0.79	0.98	0.02	6.70E-02	1.67E-04	1.11E-04	6.73E-02
Chromium	4.9	0.000	0.038	0.19	0.98	0.02	1.59E-02	1.70E-04	0.00E+00	1.60E-02	4.2	0.000	0.038	0.16	0.98	0.02	1.36E-02	1.46E-04	0.00E+00	1.37E-02
Copper	212	0.0197	0.100	21.2	0.98	0.02	1.81E+00	7.37E-03	2.19E-03	1.81E+00	147	0.0138	0.100	14.7	0.98	0.02	1.25E+00	5.11E-03	1.53E-03	1.26E+00
Lead	367	0.0231	0.070	26	0.98	0.02	2.19E+00	1.28E-02	2.56E-03	2.20E+00	300	0.0112	0.070	21	0.98	0.02	1.79E+00	1.04E-02	1.24E-03	1.80E+00
Mercury (inorganic)	0.04	0.000	3.25	0.130	0.98	0.02	1.11E-02	1.39E-06	0.00E+00	1.11E-02	0.04	0.000	3.25	0.130	0.98	0.02	1.11E-02	1.39E-06	0.00E+00	1.11E-02
Nickel	12.4	0.000	1.00	12.4	0.98	0.02	1.06E+00	4.31E-04	0.00E+00	1.06E+00	9.4	0.000	1.00	9.4	0.98	0.02	8.01E-01	3.27E-04	0.00E+00	8.01E-01
Selenium	1.4	0.000	1.00	1.40	0.98	0.02	1.19E-01	4.87E-05	0.00E+00	1.19E-01	1.20	0.000	1.00	1.200	0.98	0.02	1.02E-01	4.17E-05	0.00E+00	1.02E-01
Silver	1.4	0.000	1.00	1.40	0.98	0.02	1.19E-01	4.87E-05	0.00E+00	1.19E-01	1.1	0.000	1.00	1.10	0.98	0.02	9.37E-02	3.82E-05	0.00E+00	9.37E-02
Zinc	2778	0.503	0.147	408	0.98	0.02	3.48E+01	9.66E-02	5.58E-02	3.49E+01	1738	0.361	0.147	255	0.98	0.02	2.18E+01	6.04E-02	4.01E-02	2.19E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dosef_{fish} = (IR_{diet} \times C_{fish} \times DF_{fish} \times AUF)$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = (IR_{sediment} \times EPC_{sediment} \times DF_{sediment} \times AUF)$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
$\mathbf{IR_{diet}}$ (kg/kg BW-day, dw)	0.0869
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.66
EDDs for the belted kingfisher foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration: Sediment (mg/kg, dw)	RME* Exposure Point Concentration: Surface Water (mg/L)	EDD (mg/kg bw-day) Diet: BSAFs	Diet: Fish Tissue Concentation ($C_{fish, dw}$)	Diet: DF_{fish}	Diet: $DF_{sediment}$	Diet: $Dose_{fish}$[1]	Sediment: $Dose_{sediment}$[2]	Water: $Dose_{water}$[3]	Total EDD[4]	CTE** Exposure Point Concentration: Sediment (mg/kg, dw)	CTE** Exposure Point Concentration: Surface Water (mg/L)	EDD (mg/kg bw-day) Diet: BSAFs	Diet: Fish Tissue Concentation ($C_{fish, dw}$)	Diet: DF_{Fish}	Diet: $DF_{sediment}$	Diet: $Dose_{fish}$[1]	Sediment: $Dose_{sediment}$[2]	Water: $Dose_{water}$[3]	Total EDD[4]
Arsenic	37.2	0.000	0.126	4.69	0.98	0.02	3.99E-01	1.29E-03	0.00E+00	4.00E-01	19.9	0.000	0.126	2.51	0.98	0.02	2.14E-01	6.92E-04	0.00E+00	2.14E-01
Cadmium	10.5	0.0011	0.164	1.72	0.98	0.02	1.47E-01	3.65E-04	1.22E-04	1.47E-01	5.0	0.0009	0.164	0.82	0.98	0.02	6.98E-02	1.74E-04	9.99E-05	7.01E-02
Chromium	5.5	0.000	0.038	0.21	0.98	0.02	1.78E-02	1.91E-04	0.00E+00	1.80E-02	5.2	0.000	0.038	0.20	0.98	0.02	1.68E-02	1.81E-04	0.00E+00	1.70E-02
Copper	413	0.0215	0.100	41.3	0.98	0.02	3.52E+00	1.44E-02	2.39E-03	3.53E+00	188	0.0122	0.100	18.8	0.98	0.02	1.60E+00	6.53E-03	1.35E-03	1.61E+00
Lead	435	0.0303	0.070	30	0.98	0.02	2.59E+00	1.51E-02	3.36E-03	2.61E+00	296	0.0121	0.070	21	0.98	0.02	1.76E+00	1.03E-02	1.34E-03	1.78E+00
Mercury (inorganic)	0.07	0.000	3.25	0.228	0.98	0.02	1.94E-02	2.43E-06	0.00E+00	1.94E-02	0.07	0.000	3.25	0.228	0.98	0.02	1.94E-02	2.43E-06	0.00E+00	1.94E-02
Nickel	16.5	0.000	1.00	16.5	0.98	0.02	1.41E+00	5.74E-04	0.00E+00	1.41E+00	9.7	0.000	1.00	9.7	0.98	0.02	8.26E-01	3.37E-04	0.00E+00	8.26E-01
Selenium	3.3	0.000	1.00	3.30	0.98	0.02	2.81E-01	1.15E-04	0.00E+00	2.81E-01	1.9	0.000	1.00	1.900	0.98	0.02	1.62E-01	6.60E-05	0.00E+00	1.62E-01
Silver	2.2	0.000	1.00	2.20	0.98	0.02	1.87E-01	7.65E-05	0.00E+00	1.87E-01	1.4	0.000	1.00	1.40	0.98	0.02	1.19E-01	4.87E-05	0.00E+00	1.19E-01
Zinc	5320	0.429	0.147	782	0.98	0.02	6.66E+01	1.85E-01	4.76E-02	6.68E+01	2190	0.302	0.147	322	0.98	0.02	2.74E+01	7.61E-02	3.35E-02	2.75E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{fish} = (IR_{diet} \times C_{fish} \times DF_{fish} \times AUF)$
Where $C_{fish} = EPC_{sediment} \times BSAF$
2 $Dose_{sediment} = (IR_{sediment} \times EPC_{sediment} \times DF_{sediment} \times AUF)$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.67
EDDs for the belted kingfisher foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet						Water				Diet						Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Fish Tissue Concentation ($C_{fish, dw}$)	DF_{Fish}	DF sediment	$Dose_{fish}$[1]	$Dose_{sediment}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	29.7	0.000	0.126	3.74	0.98	0.02	3.19E-01	1.03E-03	0.00E+00	3.20E-01	21.9	0.000	0.126	2.76	0.98	0.02	2.35E-01	7.61E-04	0.00E+00	2.36E-01
Cadmium	18.6	0.0008	0.164	3.05	0.98	0.02	2.60E-01	6.47E-04	8.88E-05	2.61E-01	10.1	0.0007	0.164	1.66	0.98	0.02	1.41E-01	3.51E-04	7.77E-05	1.41E-01
Chromium	7.0	0.000	0.038	0.27	0.98	0.02	2.27E-02	2.43E-04	0.00E+00	2.29E-02	5.4	0.000	0.038	0.21	0.98	0.02	1.75E-02	1.88E-04	0.00E+00	1.77E-02
Copper	332	0.0138	0.100	33.2	0.98	0.02	2.83E+00	1.15E-02	1.53E-03	2.84E+00	191	0.0095	0.100	19.1	0.98	0.02	1.63E+00	6.64E-03	1.05E-03	1.63E+00
Lead	376	0.0177	0.070	26	0.98	0.02	2.24E+00	1.31E-02	1.96E-03	2.26E+00	300	0.0078	0.070	21	0.98	0.02	1.79E+00	1.04E-02	8.66E-04	1.80E+00
Mercury (inorganic)	0.06	0.000	3.25	0.195	0.98	0.02	1.66E-02	2.09E-06	0.00E+00	1.66E-02	0.04	0.000	3.25	0.130	0.98	0.02	1.11E-02	1.39E-06	0.00E+00	1.11E-02
Nickel	31.0	0.000	1.00	31.0	0.98	0.02	2.64E+00	1.08E-03	0.00E+00	2.64E+00	18.3	0.000	1.00	18.3	0.98	0.02	1.56E+00	6.36E-04	0.00E+00	1.56E+00
Selenium	3.1	0.000	1.00	3.10	0.98	0.02	2.64E-01	1.08E-04	0.00E+00	2.64E-01	2.1	0.000	1.00	2.100	0.98	0.02	1.79E-01	7.30E-05	0.00E+00	1.79E-01
Silver	1.7	0.000	1.00	1.70	0.98	0.02	1.45E-01	5.91E-05	0.00E+00	1.45E-01	1.3	0.000	1.00	1.30	0.98	0.02	1.11E-01	4.52E-05	0.00E+00	1.11E-01
Zinc	8544	0.272	0.147	1256	0.98	0.02	1.07E+02	2.97E-01	3.02E-02	1.07E+02	4620	0.216	0.147	679	0.98	0.02	5.78E+01	1.61E-01	2.40E-02	5.80E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dosef_{ish} = (IR_{diet} X C_{fish} X DF_{fish} X AUF)$
Where $C_{fish} = EPC_{sediment} X BSAF$
2 $Dose_{sediment} = (IR_{sediment} X EPC_{sediment} X DF_{sediment} X AUF)$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{fish} + Dose_{sediment} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	0.147
IR_{diet} (kg/kg BW-day, dw)	0.0869
IR_{water} (L/kg BW-day)	0.111
IRsed (kg/kg BW-day, dw)	0.001738

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 4.68
EDDs for the muskrat foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}^{1}$	$Dose_{sed}^{2}$	$Dose_{water}^{3}$	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}^{1}$	$Dose_{sed}^{2}$	$Dose_{water}^{3}$	Total EDD[4]
Arsenic	34.2	0.000	Equation	1.00	0.9	0.1	7.55E-02	2.87E-02	0.00E+00	1.04E-01	27.4	0.000	Equation	0.88	0.9	0.1	6.66E-02	2.30E-02	0.00E+00	8.96E-02
Cadmium	12.9	0.0016	Equation	2.51	0.9	0.1	1.90E-01	1.08E-02	1.56E-04	2.01E-01	11.1	0.0014	Equation	2.31	0.9	0.1	1.75E-01	9.31E-03	1.37E-04	1.84E-01
Chromium	5.0	0.000	0.04	0.21	0.9	0.1	1.55E-02	4.20E-03	0.00E+00	1.97E-02	4.7	0.000	0.04	0.19	0.9	0.1	1.46E-02	3.94E-03	0.00E+00	1.85E-02
Copper	399	0.0162	Equation	20.7	0.9	0.1	1.56E+00	3.35E-01	1.58E-03	1.90E+00	339	0.0155	Equation	19.4	0.9	0.1	1.46E+00	2.84E-01	1.51E-03	1.75E+00
Lead	1733	0.0219	Equation	17.4	0.9	0.1	1.31E+00	1.45E+00	2.14E-03	2.77E+00	1508	0.0116	Equation	16.1	0.9	0.1	1.21E+00	1.27E+00	1.13E-03	2.48E+00
Mercury	0.10	0.000	Equation	0.11	0.9	0.1	7.97E-03	8.39E-05	0.00E+00	8.05E-03	0.07	0.000	Equation	0.09	0.9	0.1	6.56E-03	5.87E-05	0.00E+00	6.62E-03
Nickel	9.2	0.000	Equation	0.57	0.9	0.1	4.30E-02	7.72E-03	0.00E+00	5.07E-02	8.2	0.000	Equation	0.52	0.9	0.1	3.94E-02	6.88E-03	0.00E+00	4.63E-02
Selenium	1.0	0.000	Equation	0.51	0.9	0.1	3.82E-02	8.37E-04	0.00E+00	3.91E-02	1.5	0.000	Equation	0.79	0.9	0.1	6.00E-02	1.26E-03	0.00E+00	6.12E-02
Silver	6.4	0.000	0.014	0.090	0.9	0.1	6.77E-03	5.37E-03	0.00E+00	1.21E-02	5.5	0.000	0.014	0.077	0.9	0.1	5.81E-03	4.61E-03	0.00E+00	1.04E-02
Zinc	4054	0.488	Equation	486	0.9	0.1	3.67E+01	3.40E+00	4.76E-02	4.01E+01	3172	0.432	Equation	424	0.9	0.1	3.20E+01	2.66E+00	4.21E-02	3.47E+01

mg/kg - milligrams per kilogram
mg/L - milligramsper liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - EstimatedDaily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or gegression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{plant} = IR_{diet} X\ C_{plant} X\ DF_{invert} X\ AUF$
Where $C_{plant} = (EPC_{sediment} X\ BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} X\ EPC_{sediment} X\ Df_{sed} X\ AUF$
3 $Dose_{water} = IR_{water} X\ C_{water} X\ AUF$
4 Total EDD = $Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
$\mathbf{IR_{plant}}$ (kg/kg BW-day, dw)	0.0839
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.0975
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.00839

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Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 4.69
EDDs for the muskrat foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* ExposurePoint Concentration		EDD (mg/kg bw-day)								CTE** ExposurePoint Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.6	0.0050	Equation	1.09	0.9	0.1	8.20E-02	3.32E-02	4.88E-04	1.16E-01	33.4	0.0050	Equation	0.99	0.9	0.1	7.45E-02	2.80E-02	4.88E-04	1.03E-01
Cadmium	2.9	0.002	Equation	1.11	0.9	0.1	8.39E-02	2.43E-03	1.85E-04	8.65E-02	2.1	0.0016	Equation	0.93	0.9	0.1	7.03E-02	1.76E-03	1.56E-04	7.23E-02
Chromium	6.1	0.000	0.04	0.25	0.9	0.1	1.89E-02	5.12E-03	0.00E+00	2.40E-02	4.6	0.000	0.04	0.19	0.9	0.1	1.42E-02	3.86E-03	0.00E+00	1.81E-02
Copper	173	0.0307	Equation	14.9	0.9	0.1	1.12E+00	1.45E-01	2.99E-03	1.27E+00	137	0.0274	Equation	13.6	0.9	0.1	1.02E+00	1.15E-01	2.67E-03	1.14E+00
Lead	581	0.0305	Equation	9.4	0.9	0.1	7.11E-01	4.87E-01	2.97E-03	1.20E+00	478	0.0128	Equation	8.4	0.9	0.1	6.37E-01	4.01E-01	1.25E-03	1.04E+00
Mercury	0.070	0.000	Equation	0.09	0.9	0.1	6.56E-03	5.87E-05	0.00E+00	6.62E-03	0.06	0.000	Equation	0.08	0.9	0.1	6.04E-03	5.03E-05	0.00E+00	6.09E-03
Nickel	5.9	0.0037	Equation	0.41	0.9	0.1	3.08E-02	4.95E-03	3.61E-04	3.61E-02	5.1	0.0050	Equation	0.37	0.9	0.1	2.76E-02	4.28E-03	4.88E-04	3.24E-02
Selenium	1.9	0.000	Equation	1.03	0.9	0.1	7.79E-02	1.59E-03	0.00E+00	7.95E-02	1.5	0.000	Equation	0.79	0.9	0.1	6.00E-02	1.26E-03	0.00E+00	6.12E-02
Silver	2.4	0.000	0.014	0.034	0.9	0.1	2.54E-03	2.01E-03	0.00E+00	4.55E-03	1.9	0.000	0.014	0.027	0.9	0.1	2.01E-03	1.59E-03	0.00E+00	3.60E-03
Zinc	819	0.711	Equation	200	0.9	0.1	1.51E+01	6.87E-01	6.93E-02	1.59E+01	651	0.600	Equation	176	0.9	0.1	1.33E+01	5.46E-01	5.85E-02	1.39E+01

mg/kg - milligrams per kilogram
mg/L - milligramsper liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{plant} = IR_{diet} X C_{plant} X DF_{invert} X AUF$
Where $C_{plant} = (EPC_{sediment} X BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} X EPC_{sediment} X Df_{sed} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total EDD = $Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
IR_{plant} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

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Table 4.70
EDDs for the muskrat foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Arsenic	33.8	0.000	Equation	0.99	0.9	0.1	7.50E-02	2.84E-02	0.00E+00	1.03E-01	27.9	0.000	Equation	0.89	0.9	0.1	6.73E-02	2.34E-02	0.00E+00	9.07E-02
Cadmium	5.4	0.0021	Equation	1.56	0.9	0.1	1.18E-01	4.53E-03	2.05E-04	1.23E-01	4.0	0.0015	Equation	1.32	0.9	0.1	1.00E-01	3.36E-03	1.46E-04	1.04E-01
Chromium	5.4	0.000	0.04	0.22	0.9	0.1	1.67E-02	4.53E-03	0.00E+00	2.12E-02	4.0	0.000	0.04	0.16	0.9	0.1	1.24E-02	3.36E-03	0.00E+00	1.57E-02
Copper	284	0.0228	Equation	18.1	0.9	0.1	1.37E+00	2.38E-01	2.22E-03	1.61E+00	199	0.0178	Equation	15.7	0.9	0.1	1.19E+00	1.67E-01	1.74E-03	1.36E+00
Lead	729	0.0234	Equation	10.7	0.9	0.1	8.08E-01	6.12E-01	2.28E-03	1.42E+00	513	0.0111	Equation	8.8	0.9	0.1	6.63E-01	4.30E-01	1.08E-03	1.09E+00
Mercury	0.05	0.000	Equation	0.07	0.9	0.1	5.47E-03	4.20E-05	0.00E+00	5.51E-03	0.04	0.000	Equation	0.06	0.9	0.1	4.84E-03	3.36E-05	0.00E+00	4.87E-03
Nickel	7.2	0.0038	Equation	0.47	0.9	0.1	3.58E-02	6.04E-03	3.71E-04	4.22E-02	6.4	0.0038	Equation	0.43	0.9	0.1	3.27E-02	5.37E-03	3.71E-04	3.85E-02
Selenium	1.4	0.000	Equation	0.74	0.9	0.1	5.56E-02	1.17E-03	0.00E+00	5.67E-02	1.1	0.000	Equation	0.56	0.9	0.1	4.26E-02	9.23E-04	0.00E+00	4.35E-02
Silver	2.8	0.000	0.014	0.039	0.9	0.1	2.96E-03	2.35E-03	0.00E+00	5.31E-03	1.9	0.000	0.014	0.027	0.9	0.1	2.01E-03	1.59E-03	0.00E+00	3.60E-03
Zinc	1393	0.704	Equation	268	0.9	0.1	2.03E+01	1.17E+00	6.86E-02	2.15E+01	1049	0.521	Equation	229	0.9	0.1	1.73E+01	8.80E-01	5.08E-02	1.83E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{plant} = IR_{diet} X C_{plant} X DF_{invert} X AUF$
Where $C_{plant} = (EPC_{sediment} X BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} X EPC_{sediment} X Df_{sed} X AUF$
3 $Dose_{water} = IR_{water} X C_{water} X AUF$
4 Total $EDD = Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
IR_{plant} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

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Table 4.71
EDDs for the muskrat foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	39.4	0.000	Equation	1.08	0.9	0.1	8.18E-02	3.31E-02	0.00E+00	1.15E-01	29.9	0.000	Equation	0.93	0.9	0.1	7.00E-02	2.51E-02	0.00E+00	9.51E-02
Cadmium	4.2	0.0015	Equation	1.36	0.9	0.1	1.03E-01	3.52E-03	1.46E-04	1.06E-01	3.5	0.0010	Equation	1.23	0.9	0.1	9.30E-02	2.94E-03	9.75E-05	9.60E-02
Chromium	5.0	0.0058	0.04	0.21	0.9	0.1	1.55E-02	4.20E-03	5.66E-04	2.02E-02	4.5	0.0058	0.04	0.18	0.9	0.1	1.39E-02	3.78E-03	5.66E-04	1.83E-02
Copper	292	0.0131	Equation	18.3	0.9	0.1	1.38E+00	2.45E-01	1.28E-03	1.63E+00	177	0.0094	Equation	15.0	0.9	0.1	1.13E+00	1.49E-01	9.17E-04	1.28E+00
Lead	593	0.0106	Equation	9.5	0.9	0.1	7.19E-01	4.98E-01	1.03E-03	1.22E+00	534	0.0055	Equation	9.0	0.9	0.1	6.78E-01	4.48E-01	5.36E-04	1.13E+00
Mercury	0.09	0.000	Equation	0.10	0.9	0.1	7.53E-03	7.55E-05	0.00E+00	7.60E-03	0.07	0.000	Equation	0.09	0.9	0.1	6.56E-03	5.87E-05	0.00E+00	6.62E-03
Nickel	12.1	0.0029	Equation	0.70	0.9	0.1	5.27E-02	1.02E-02	2.83E-04	6.32E-02	10.0	0.0029	Equation	0.61	0.9	0.1	4.57E-02	8.39E-03	2.83E-04	5.44E-02
Selenium	2.9	0.000	Equation	1.64	0.9	0.1	1.24E-01	2.43E-03	0.00E+00	1.27E-01	2.9	0.000	Equation	1.64	0.9	0.1	1.24E-01	2.43E-03	0.00E+00	1.27E-01
Silver	3.1	0.000	0.014	0.043	0.9	0.1	3.28E-03	2.60E-03	0.00E+00	5.88E-03	2.0	0.000	0.014	0.028	0.9	0.1	2.11E-03	1.68E-03	0.00E+00	3.79E-03
Zinc	1720	0.498	Equation	302	0.9	0.1	2.28E+01	1.44E+00	4.86E-02	2.43E+01	1114	0.265	Equation	237	0.9	0.1	1.79E+01	9.35E-01	2.58E-02	1.89E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
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EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{plant} = IR_{diet}$ X C_{plant} X DF_{invert} X AUF
Where C_{plant} = ($EPC_{sediment}$ X BSAF) or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment}$ X $EPC_{sediment}$ X Df_{sed} X AUF
3 $Dose_{water} = IR_{water}$ X C_{water} X AUF
4 Total EDD = $Dose_{invert}$ + $Dose_{sed}$ + $Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
$\mathbf{IR_{plant}}$ (kg/kg BW-day, dw)	0.0839
$\mathbf{IR_{water}}$ (L/kg BW-day)	0.0975
$\mathbf{IR_{sediment}}$ (kg/kg BW-day, dw)	0.00839

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Table 4.72
EDDs for the muskrat foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	27.0	0.000	Equation	0.88	0.9	0.1	6.61E-02	2.27E-02	0.00E+00	8.87E-02	19.4	0.000	Equation	0.73	0.9	0.1	5.49E-02	1.63E-02	0.00E+00	7.11E-02
Cadmium	6.4	0.0014	Equation	1.71	0.9	0.1	1.29E-01	5.37E-03	1.37E-04	1.35E-01	4.8	0.0010	Equation	1.46	0.9	0.1	1.10E-01	4.03E-03	9.75E-05	1.15E-01
Chromium	4.9	0.000	0.04	0.20	0.9	0.1	1.52E-02	4.11E-03	0.00E+00	1.93E-02	4.2	0.000	0.04	0.17	0.9	0.1	1.30E-02	3.52E-03	0.00E+00	1.65E-02
Copper	212	0.0197	Equation	16.1	0.9	0.1	1.22E+00	1.78E-01	1.92E-03	1.40E+00	147	0.0138	Equation	13.9	0.9	0.1	1.05E+00	1.23E-01	1.35E-03	1.18E+00
Lead	367	0.0231	Equation	7.3	0.9	0.1	5.50E-01	3.08E-01	2.25E-03	8.60E-01	300	0.0112	Equation	6.5	0.9	0.1	4.91E-01	2.52E-01	1.09E-03	7.44E-01
Mercury	0.04	0.000	Equation	0.06	0.9	0.1	4.84E-03	3.36E-05	0.00E+00	4.87E-03	0.04	0.000	Equation	0.06	0.9	0.1	4.84E-03	3.36E-05	0.00E+00	4.87E-03
Nickel	12.4	0.000	Equation	0.71	0.9	0.1	5.37E-02	1.04E-02	0.00E+00	6.41E-02	9.4	0.000	Equation	0.58	0.9	0.1	4.37E-02	7.89E-03	0.00E+00	5.15E-02
Selenium	1.4	0.000	Equation	0.74	0.9	0.1	5.56E-02	1.17E-03	0.00E+00	5.67E-02	1.20	0.000	Equation	0.62	0.9	0.1	4.69E-02	1.01E-03	0.00E+00	4.79E-02
Silver	1.4	0.000	0.014	0.020	0.9	0.1	1.48E-03	1.17E-03	0.00E+00	2.65E-03	1.1	0.000	0.014	0.015	0.9	0.1	1.16E-03	9.23E-04	0.00E+00	2.09E-03
Zinc	2778	0.503	Equation	394	0.9	0.1	2.97E+01	2.33E+00	4.90E-02	3.21E+01	1738	0.361	Equation	304	0.9	0.1	2.29E+01	1.46E+00	3.52E-02	2.44E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{invert} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
IR_{plant} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

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Copy of 2015 final BERA Tables 4 series.xlsx4.72

Table 4.73
EDDs for the muskrat foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant,dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant Tissue Concentration ($C_{plant,dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$[1]	$Dose_{sed}$[2]	$Dose_{water}$[3]	Total EDD[4]
Metals																				
Arsenic	37.2	0.000	Equation	1.05	0.9	0.1	7.92E-02	3.12E-02	0.00E+00	1.10E-01	19.9	0.000	Equation	0.74	0.9	0.1	5.56E-02	1.67E-02	0.00E+00	7.23E-02
Cadmium	10.5	0.0011	Equation	2.24	0.9	0.1	1.69E-01	8.81E-03	1.07E-04	1.78E-01	5.0	0.0009	Equation	1.50	0.9	0.1	1.13E-01	4.20E-03	8.78E-05	1.17E-01
Chromium	5.5	0.000	0.04	0.23	0.9	0.1	1.70E-02	4.61E-03	0.00E+00	2.16E-02	5.2	0.000	0.04	0.21	0.9	0.1	1.61E-02	4.36E-03	0.00E+00	2.05E-02
Copper	413	0.0215	Equation	21.0	0.9	0.1	1.58E+00	3.47E-01	2.10E-03	1.93E+00	188	0.0122	Equation	15.4	0.9	0.1	1.16E+00	1.58E-01	1.19E-03	1.32E+00
Lead	435	0.0303	Equation	8.0	0.9	0.1	6.05E-01	3.65E-01	2.95E-03	9.72E-01	296	0.0121	Equation	6.5	0.9	0.1	4.87E-01	2.48E-01	1.18E-03	7.37E-01
Mercury	0.07	0.000	Equation	0.09	0.9	0.1	6.56E-03	5.87E-05	0.00E+00	6.62E-03	0.07	0.000	Equation	0.09	0.9	0.1	6.56E-03	5.87E-05	0.00E+00	6.62E-03
Nickel	16.5	0.000	Equation	0.88	0.9	0.1	6.65E-02	1.38E-02	0.00E+00	8.03E-02	9.7	0.000	Equation	0.59	0.9	0.1	4.47E-02	8.14E-03	0.00E+00	5.28E-02
Selenium	3.3	0.000	Equation	1.90	0.9	0.1	1.43E-01	2.77E-03	0.00E+00	1.46E-01	1.9	0.000	Equation	1.03	0.9	0.1	7.79E-02	1.59E-03	0.00E+00	7.95E-02
Silver	2.2	0.000	0.014	0.031	0.9	0.1	2.33E-03	1.85E-03	0.00E+00	4.17E-03	1.4	0.000	0.014	0.020	0.9	0.1	1.48E-03	1.17E-03	0.00E+00	2.65E-03
Zinc	5320	0.429	Equation	565	0.9	0.1	4.26E+01	4.46E+00	4.18E-02	4.72E+01	2190	0.302	Equation	345	0.9	0.1	2.61E+01	1.84E+00	2.94E-02	2.79E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations
1 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{invert} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
IR_{plant} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Table 4.74
EDDs for the muskrat foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME* Exposure Point Concentration		EDD (mg/kg bw-day)								CTE** Exposure Point Concentration		EDD (mg/kg bw-day)							
			Diet					Sediment	Water				Diet					Sediment	Water	
COPECs	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]	Sediment (mg/kg, dw)	Surface Water (mg/L)	BSAFs	Plant tissue Concentration ($C_{plant, dw}$)	DF_{plant}	$Df_{sediment}$	$Dose_{plant}$ [1]	$Dose_{sed}$ [2]	$Dose_{water}$ [3]	Total EDD[4]
Arsenic	29.7	0	Equation	0.92	0.9	0.1	6.97E-02	2.49E-02	0.00E+00	9.47E-02	21.9	0	Equation	0.78	0.9	0.1	5.87E-02	1.84E-02	0.00E+00	7.71E-02
Cadmium	18.6	0.0008	Equation	3.06	0.9	0.1	2.31E-01	1.56E-02	7.80E-05	2.47E-01	10.1	0.0007	Equation	2.20	0.9	0.1	1.66E-01	8.47E-03	6.83E-05	1.74E-01
Chromium	7.0	0	0.04	0.29	0.9	0.1	2.17E-02	5.87E-03	0.00E+00	2.75E-02	5.4	0	0.04	0.22	0.9	0.1	1.67E-02	4.53E-03	0.00E+00	2.12E-02
Copper	332	0.0138	Equation	19.2	0.9	0.1	1.45E+00	2.79E-01	1.35E-03	1.73E+00	191	0.0095	Equation	15.5	0.9	0.1	1.17E+00	1.60E-01	9.26E-04	1.33E+00
Lead	376	0.0177	Equation	7.4	0.9	0.1	5.57E-01	3.15E-01	1.73E-03	8.74E-01	300	0.0078	Equation	6.5	0.9	0.1	4.91E-01	2.52E-01	7.61E-04	7.43E-01
Mercury	0.06	0	Equation	0.08	0.9	0.1	6.04E-03	5.03E-05	0.00E+00	6.09E-03	0.04	0	Equation	0.06	0.9	0.1	4.84E-03	3.36E-05	0.00E+00	4.87E-03
Nickel	31.0	0	Equation	1.41	0.9	0.1	1.07E-01	2.60E-02	0.00E+00	1.33E-01	18.3	0	Equation	0.95	0.9	0.1	7.19E-02	1.54E-02	0.00E+00	8.72E-02
Selenium	3.1	0	Equation	1.77	0.9	0.1	1.34E-01	2.60E-03	0.00E+00	1.36E-01	2.1	0	Equation	1.15	0.9	0.1	8.70E-02	1.76E-03	0.00E+00	8.87E-02
Silver	1.7	0	0.014	0.024	0.9	0.1	1.80E-03	1.43E-03	0.00E+00	3.22E-03	1.3	0	0.014	0.018	0.9	0.1	1.37E-03	1.09E-03	0.00E+00	2.46E-03
Zinc	8544	0.272	Equation	735	0.9	0.1	5.55E+01	7.17E+00	2.65E-02	6.27E+01	4620	0.216	Equation	522	0.9	0.1	3.94E+01	3.88E+00	2.11E-02	4.33E+01

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor or regression equation
* The RME value represents the 95% UCL or the maximum detected concentration if a 95% UCL could not be calculated.
** The CTE values represents the mean concentration.

Equations

1 $Dose_{plant} = IR_{diet} \times C_{plant} \times DF_{invert} \times AUF$
Where $C_{plant} = (EPC_{sediment} \times BSAF)$ or the result of the BSAF regression equation
2 $Dose_{sed} = Ir_{sediment} \times EPC_{sediment} \times Df_{sed} \times AUF$
3 $Dose_{water} = IR_{water} \times C_{water} \times AUF$
4 Total EDD = $Dose_{invert} + Dose_{sed} + Dose_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW) (kg)	1.17
IR_{plant} (kg/kg BW-day, dw)	0.0839
IR_{water} (L/kg BW-day)	0.0975
$IR_{sediment}$ (kg/kg BW-day, dw)	0.00839

Table 5.1
Summary of the risk estimation approaches by receptor group, exposure unit, and measurement endpoint
Baseline Ecological Risk Assessments
Upper Animas Mining District

receptor group	exposure units[a]	measurement endpoint: exposure	measurement endpoint: effect	risk estimation approach
benthic invertebrate community	CC, MC, AR above CC, AR below MC	total metals in bulk sediment	no effect & effect sediment benchmarks	HQ method
	MC, AR above CC, AR below MC,	dissolved metals in pore water	chronic surface water benchmarks	HQ method
	CC, MC, AR above CC, and AR below MR	10-day sediment toxicity test using juvenile amphipods (*Hyalella azteca*)		statistical method
	CC, MC, AR above CC, and AR below MR	macroinvertebrate benthic community survey		graphical analysis
fish community	CC, MC, AR above CC, AR between CC & MR, AR below MC	total or dissolved metals in surface water	chronic surface water benchmarks	HQ method
	CC, MC, AR above CC, AR below MC	96-hour acute surface water toxicity tests using juvenile rainbow trout		statistical method
insectivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
omnivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
piscivorous birds	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	bird no-effect and effect TRVs	HQ method
herbivorous mammals	AR aboce CC; AR below MC	exposure modeling to calculate RME and CTE EDDs	mammal no-effect and effect TRVs	HQ method

[a] CC = Cement Creek; MC = Mineral Creek; AR = Animas River
CTE = central tendency exposure
EDD = estimated daily dose
HQ = hazard quotient
RME = reasonable maximum exposure
TRV = toxicity reference value

created by: SJP (1/9/14)
reviewed by: EC (3/16/15)

Table 5.2
Sediment HQs for mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Arsenic	32.7	26.9	9.8	33	**3.3**	**2.7**	<1	<1
Copper	127	90.4	31.6	149	**4.0**	**2.9**	<1	<1
Lead	237	183	35.8	128	**6.6**	**5.1**	**1.9**	**1.4**
Manganese	1430	1295	630	1,200	**2.3**	**2.1**	**1.2**	**1.1**
Selenium	1.7	1.7	0.9	4.7	**1.9**	**1.9**	<1	<1
Zinc	666	468	121	459	**5.5**	**3.9**	**1.5**	**1.02**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.3
Sediment HQs for mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Arsenic	40.6	40.6	9.8	33	**4.1**	**4.1**	**1.2**	**1.2**
Copper	55.6	55.6	31.6	149	**1.8**	**1.8**	<1	<1
Lead	282	282	35.8	128	**7.9**	**7.9**	**2.2**	**2.2**
Silver	2.0	2.0	1.0	3.7	**2.0**	**2.0**	<1	<1
Zinc	195	195	121	459	**1.6**	**1.6**	<1	<1

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.4
Sediment HQs for the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Arsenic	34.2	27.4	9.8	33	**3.5**	**2.8**	**1.04**	<1
Cadmium	12.9	11.1	0.99	4.98	**13.0**	**11.2**	**2.6**	**2.2**
Copper	399	339	31.6	149	**12.6**	**10.7**	**2.7**	**2.3**
Lead	1733	1508	35.8	128	**48.4**	**42.1**	**13.5**	**11.8**
Manganese	12566	10617	630	1,200	**19.9**	**16.9**	**10.5**	**8.8**
Mercury	0.09	0.07	0.18	1.06	<1	<1	<1	<1
Selenium	0.998	1.54	0.9	4.7	**1.1**	**1.7**	<1	<1
Silver	6.4	5.5	1.0	3.7	**6.4**	**5.5**	**1.7**	**1.5**
Zinc	4054	3172	121	459	**33.5**	**26.2**	**8.8**	**6.9**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.5
Sediment HQs for sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Aluminum	19,659	14,872	26,000	60,000	<1	<1	<1	<1
Arsenic	39.6	33.4	9.8	33	**4.0**	**3.4**	**1.2**	**1.01**
Cadmium	2.9	2.1	1.0	4.98	**2.9**	**2.1**	<1	<1
Copper	173	137	31.6	149	**5.5**	**4.3**	**1.2**	**<1**
Lead	581	478	35.8	128	**16.2**	**13.4**	**4.5**	**3.7**
Manganese	2,979	2,100	630	1,200	**4.7**	**3.3**	**2.5**	**1.8**
Nickel	5.9	5.1	22.7	48.6	<1	<1	<1	<1
Selenium	1.9	1.5	0.9	4.7	**2.1**	**1.7**	<1	<1
Silver	2.4	1.9	1.0	3.7	**2.4**	**1.9**	<1	<1
Zinc	819	651	121	459	**6.8**	**5.4**	**1.8**	**1.4**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.6
Sediment HQs for sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Aluminum	35,775	17,123	26,000	60,000	**1.4**	<1	<1	<1
Arsenic	33.8	27.9	9.8	33	**3.4**	**2.9**	**1.02**	<1
Cadmium	5.4	4.0	1.0	4.98	**5.5**	**4.1**	**1.1**	<1
Copper	284	199	31.6	149	**9.0**	**6.3**	**1.9**	**1.3**
Lead	729	513	35.8	128	**20.4**	**14.3**	**5.7**	**4.0**
Manganese	6,618	4,340	630	1,200	**10.5**	**6.9**	**5.5**	**3.6**
Nickel	7.2	6.4	22.7	48.6	<1	<1	<1	<1
Selenium	1.4	1.1	0.9	4.7	**1.6**	**1.2**	<1	<1
Silver	2.8	1.9	1.0	3.7	**2.8**	**1.9**	<1	<1
Zinc	1,393	1,049	121	459	**11.5**	**8.7**	**3.0**	**2.3**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.7
Sediment HQs for sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	31,900	16,373	26,000	60,000	**1.2**	<1	<1	<1
Arsenic	39.4	29.9	9.8	33	**4.0**	**3.1**	**1.2**	<1
Cadmium	4.2	3.5	1.0	4.98	**4.3**	**3.5**	<1	<1
Copper	292	177	31.6	149	**9.2**	**5.6**	**2.0**	**1.2**
Lead	593	534	35.8	128	**16.6**	**14.9**	**4.6**	**4.2**
Manganese	4,340	3,143	630	1,200	**6.9**	**5.0**	**3.6**	**2.6**
Nickel	12.1	10.0	22.7	48.6	<1	<1	<1	<1
Selenium	2.9	2.9	0.9	4.7	**3.2**	**3.2**	<1	<1
Silver	3.1	2.0	1.0	3.7	**3.1**	**2.0**	<1	<1
Zinc	1,720	1,114	121	459	**14.2**	**9.2**	**3.7**	**2.4**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.8
Sediment HQs for sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Aluminum	27,525	15,428	26,000	60,000	**1.1**	<1	<1	<1
Arsenic	27.0	19.4	9.8	33	**2.8**	**2.0**	<1	<1
Cadmium	6.4	4.8	1.0	4.98	**6.5**	**4.9**	**1.3**	<1
Copper	212	147	31.6	149	**6.7**	**4.6**	**1.4**	<1
Lead	367	300	35.8	128	**10.3**	**8.4**	**2.9**	**2.3**
Manganese	6,390	4,348	630	1,200	**10.1**	**6.9**	**5.3**	**3.6**
Nickel	12.4	9.4	22.7	48.6	<1	<1	<1	<1
Selenium	1.4	1.2	0.9	4.7	**1.6**	**1.4**	<1	<1
Silver	1.4	1.1	1.0	3.7	**1.4**	**1.1**	<1	<1
Zinc	2,778	1,738	121	459	**23.0**	**14.4**	**6.1**	**3.8**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.9
Sediment HQs for sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
COPECs	**RME**	**CTE**	**no effect**	**effect**	**RME**	**CTE**	**RME**	**CTE**
Aluminum	48,600	20,820	26,000	60,000	**1.9**	<1	<1	<1
Arsenic	37.2	19.9	9.8	33	**3.8**	**2.0**	**1.1**	<1
Cadmium	10.5	5.0	1.0	4.98	**10.6**	**5.1**	**2.1**	**1.01**
Copper	413	188	31.6	149	**13.1**	**5.9**	**2.8**	**1.3**
Lead	435	296	35.8	128	**12.2**	**8.3**	**3.4**	**2.3**
Manganese	3,820	2,743	630	1,200	**6.1**	**4.4**	**3.2**	**2.3**
Nickel	16.5	9.7	22.7	48.6	<1	<1	<1	<1
Selenium	3.3	1.9	0.9	4.7	**3.7**	**2.1**	<1	<1
Silver	2.2	1.4	1.0	3.7	**2.2**	**1.4**	<1	<1
Zinc	5,320	2,190	121	459	**44.0**	**18.1**	**11.6**	**4.8**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.10
Sediment HQs for sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	EPCs (mg/kg)		Sed benchmarks (mg/kg)		No Effect HQs		Effect HQs	
	RME	CTE	no effect	effect	RME	CTE	RME	CTE
Aluminum	37,400	20,025	26,000	60,000	**1.4**	<1	<1	<1
Arsenic	29.7	21.9	9.8	33	**3.0**	**2.2**	<1	<1
Cadmium	18.6	10.1	1.0	4.98	**18.8**	**10.2**	**3.7**	**2.0**
Copper	332	191	31.6	149	**10.5**	**6.0**	**2.2**	**1.3**
Lead	376	300	35.8	128	**10.5**	**8.4**	**2.9**	**2.3**
Manganese	13,100	7,425	630	1,200	**20.8**	**11.8**	**10.9**	**6.2**
Nickel	31.0	18.3	22.7	48.6	**1.4**	<1	<1	<1
Selenium	3.1	2.1	0.9	4.7	**3.4**	**2.4**	<1	<1
Silver	1.7	1.3	1.0	3.7	**1.7**	**1.3**	<1	<1
Zinc	8,544	4,620	121	459	**70.6**	**38.2**	**18.6**	**10.1**

mg/kg = milligram per kilogram
COPEC = chemical of potential ecological concern
CTE = central tendency exposure
EPC = exposure point concentration
HQ = hazard quotient
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/8/15)
reviewed by: ES (3/9/15)

Table 5.11
Average and lower hardnesses for deriving hardness-sensitive surface water benchmarks to calculate chronic HQs for pore water
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Exposure Unit	Pore water hardness (mg/L)					
	n	95% UCL	average[a]	difference[b]	ave - diff[c]	minimum[d]
Mineral Creek	1	--	139	--	--	139
Cement Creek	0	--	--	--	--	--
Animas R. above Cement Cr.	11	594.2	296	298	-2	118
Animas R. between CC & MC	0	--	--	--	--	--
A71B (Animas R. below MC)	0	--	--	--	--	--
A72 (Animas R. below MC)	2	--	208	--	--	160
A73 (Animas R. below MC)	2	--	168	--	--	151
A73B (Animas R. below MC)	1	--	49	--	--	49
A75D (Animas R. below MC)	2	--	115.5			96
A75B (Animas R. below MC)	0	--	--	--	--	--
BBridge(Animas R. below MC)	2	--	198	--	--	125

Highlighted concentrations were retained to adjust the hardness-sensitive benchmarks used in calculating the surface water HQs

note: the higher of the "ave - diff" value or "minimum" value was used to represent the estimated lower bound for pore water hardness for a given period

[a] average = arithmetic mean pore water hardness concentration

[b] difference = 95% UCL - average concentration

[c] ave - diff = concentration obtained by subtracting "difference" from "average"

[d] minimum = lowest pore water hardness measured in the samples collected from an exposure unit during the period

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/5/15
reviewed by: ES (3/10/15)

Table 5.12
Pore water HQs for benthic community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Silver	0.25	0.25	--	**--**	**--**	139	139	0.13	0.13	**1.9**	**1.9**	**1.9**	**1.9**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.13
Pore water HQs for benthic community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	4,514	1,259	87	**52**	**14**	--	--	--	--	--	--	--	--
Beryllium	10	2.2	0.66	**15**	**3.4**	--	--	--	--	--	--	--	--
Cadmium	93	24	--	--	--	118	296	0.48	0.95	**195**	**49**	**98**	**25**
Copper	2,242	224	--	--	--	118	296	10.3	22.6	**217**	**22**	**99**	**9.9**
Lead	19	14	--	--	--	118	296	3.0	8.0	**6.4**	**4.5**	**2.4**	**1.7**
Manganese	78,300	17,912	--	--	--	118	296	1,743	2,368	**45**	**10**	**33**	**7.6**
Selenium	5.0	1.6	4.6	**1.1**	<1	--	--	--	--	--	--	--	--
Silver	2.5	0.8	--	--	--	118	296	0.10	0.49	**25**	**7.9**	**5.1**	**1.6**
Zinc	19,367	5,735	--	--	--	118	296	141	325	**137**	**41**	**60**	**18**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.14
Pore water HQs for benthic community-level receptors at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	517	282	87	**5.9**	**3.2**	--	--	--	--	--	--	--	--
Beryllium	1	1	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	3.0	2.2	--	--	--	160	208	0.60	0.73	**5.0**	**3.6**	**4.1**	**3.0**
Iron	338	338	1,000	<1	<1	--	--	--	--	--	--	--	--
Manganese	995	722	--	--	--	160	208	1,929	2,105	<1	<1	<1	<1
Silver	0.25	0.25	4.6	--	--	160	208	0.17	0.26	**1.5**	**1.5**	<1	<1
Zinc	1,630	1,019	--	--	--	160	208	186	236	**8.8**	**5.5**	**6.9**	**4.3**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.15
Pore water HQs for benthic community-level receptors at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark (µg/L)	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE		RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	29	26	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	2.0	1.2	--	--	--	151	168	0.58	0.62	**3.5**	**2.1**	**3.3**	**1.9**
Iron	341	341	1,000	<1	<1	--	--	--	--	--	--	--	--
Manganese	1,870	936	--	--	--	151	168	1,892	1,961	<1	<1	<1	<1
Silver	0.25	0.25	--	--	--	151	168	0.15	0.18	**1.6**	**1.6**	**1.4**	**1.4**
Zinc	709	536	--	--	--	151	168	176	194	**4.0**	**3.0**	**3.6**	**2.8**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.16
Pore water HQs for benthic community-level receptors at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	10	10	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.1	0.1	--	--	--	49	49	0.25	0.25	<1	<1	<1	<1
Iron	50	50	1,000	<1	<1	--	--	--	--	--	--	--	--
Manganese	3.4	3.4	--	--	--	49	49	1,301	1,301	<1	<1	<1	<1
Silver	0.25	0.25	--	--	--	49	49	0.02	0.02	**11**	**11**	**11**	**11**
Zinc	33	33	--	--	--	49	49	63	63	<1	<1	<1	<1

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.17
Pore water HQs for benthic community-level receptors at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	40	34	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.79	0.59	--	--	--	96	116	0.41	0.47	**1.9**	**1.4**	**1.7**	**1.2**
Iron	107	107	1,000	<1	<1	--	--	--	--	--	--	--	--
Manganese	290	238	--	--	--	96	116	1,627	1,731	<1	<1	<1	<1
Silver	0.25	0.25	--	--	--	96	116	0.07	0.10	**3.6**	**3.6**	**2.6**	**2.6**
Zinc	190	182	--	--	--	96	116	117	138	**1.6**	**1.6**	**1.4**	**1.3**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.18
Pore water HQs for benthic community-level receptors at sampling location Bakers Bridge on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs (dissolved)	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
Aluminum	47	41	87	<1	<1	--	--	--	--	--	--	--	--
Beryllium	1.0	1.0	0.66	**1.5**	**1.5**	--	--	--	--	--	--	--	--
Cadmium	0.3	0.3	--	--	--	125	198	0.50	0.71	<1	<1	<1	<1
Iron	1,260	1,260	1,000	**1.3**	**1.3**	--	--	--	--	--	--	--	--
Manganese	5,870	3,098	--	--	--	125	198	1,777	2,071	**3.3**	**1.7**	**2.8**	**1.5**
Silver	0.25	0.25	--	--	--	125	198	0.11	0.24	**2.3**	**2.3**	**1.03**	**1.03**
Zinc	115	64	--	--	--	125	198	148	226	<1	<1	<1	<1

ug/L = microgram per liter

mg/L = milligram per liter

CTE = central tendency exposure

COPEC = contaminant of potential ecological concern

EPC = exposure point concentration

HQ = hazard quotient (concentration/benchmark)

RME = reasonable maximum exposure

prepared by: EC (3/9/15)
reviewed by: ES (3/10/15)

Table 5.19
Average and lower hardnesses used for deriving hardness-sensitive surface water benchmarks needed to calculate chronic HQs
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Exposure Unit	Pre-Runoff Period Hardness (mg/L)						Runoff Period Hardness (mg/L)						Post-Runoff Period Hardness (mg/L)					
	n	95% UCL[a]	average[b]	difference[c]	ave - diff[d]	minimum[e]	n	95% UCL	average	difference	ave - diff	minimum	n	95% UCL	average	difference	ave - diff	minimum
Mineral Creek	4	342	253	89	164	150	7	80	68	12	56	49	13	188	161	27	135	65
Cement Creek	4	619	477	143	334	301	7	157	124	33	91	76	14	475	409	66	343	67
Animas R. above Cement Cr.	5	192	170	22	148	148	17	74	69	5.1	64	49	18	136	124	12	112	66
Animas R. between CC & MC	0	--	--	--	--	--	0	--	--	--	--	--	2	--	296	--	--	295
A71B (Animas R. below MC)	0	--	--	--	--	--	0	--	--	--	--	--	1	--	263	--	--	263
A72 (Animas R. below MC)	4	378	285	93	192	177	7	87	72	15	56	45	13	221	189	32	158	75
A73 (Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	216	147	70	77	71	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A73B (Animas R. below MC)	0	--	--	--	--	--	4	194	98	96	1.6	37	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A75D (Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	161	110	50	60	60	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
A75B (Animas R. below MC)	0	--	--	--	--	--	4	174	102	72	30	61	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					
BBridge(Animas R. below MC)	the 1 pre-runoff datapoint was combined with the 2 runoff datapoints						5	155	108	47	61	58	the 2 post-runoff datapoints were combined with the 2 runoff datapoints					

Highlighted concentrations were retained to adjust the hardness-sensitive benchmarks used in calculating the surface water HQs

note: the higher of the "ave - diff" value or "minimum" value was used to represent the estimated lower bound for surface water hardness for a given period

[a] UCL = upper confidence limit for surface water hardness concentration (see Appendix X)

[b] average = arithmetic mean surface water hardness concentration

[c] difference = 95% UCL - average concentration

[d] ave - diff = concentration obtained by subtracting "difference" from "average"

[e] minimum = lowest surface water hardness concentration measured in the samples collected from an exposure unit during the period

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/5/15
reviewed by: BB (3/5/15)

Table 5.20
Surface water HQs for aquatic community-level receptors in mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	5,950	4,575	87	**68**	**53**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.3	--	--	--	164	253	0.61	0.85	**3.0**	**2.1**	**2.2**	**1.5**
Iron (total)	6,830	5,868	1,000	**6.8**	**5.9**	--	--	--	--	--	--	--	--
Silver (dissolved)	0.6	0.4	--	--	--	164	253	0.18	0.37	**3.4**	**2.3**	**1.6**	**1.1**
Zinc (dissolved)	470	358	--	--	--	164	253	190	282	**2.5**	**1.9**	**1.7**	**1.3**
RUNOFF PERIOD													
Aluminum (total)	1,910	1,353	87	**22**	**16**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.4	0.3	--	--	--	56	68	0.27	0.32	**1.5**	**1.01**	**1.3**	<1
Iron (total)	4,119	2,664	1,000	**4.1**	**2.7**	--	--	--	--	--	--	--	--
Silver (dissolved)	1.3	0.4	--	--	--	56	68	0.03	0.04	**46.9**	**14.4**	**33.6**	**10.3**
Zinc (dissolved)	104	83.9	--	--	--	56	68	72	85	**1.5**	**1.2**	**1.2**	<1
POST-RUNOFF PERIOD													
Aluminum (total)	2,826	2,267	87	**32**	**26**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.7	0.6	--	--	--	135	161	0.53	0.60	**1.4**	**1.1**	**1.2**	**1.0**
Iron (total)	4,316	3,339	1,000	**4.3**	**3.3**	--	--	--	--	--	--	--	--
Silver (dissolved)	1.3	0.3	--	--	--	135	161	0.13	0.17	**10.3**	**2.4**	**7.6**	**1.8**
Zinc (dissolved)	194	160	--	--	--	135	161	159	187	**1.2**	**1.002**	**1.04**	<1

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.21
Surface water HQs for aquatic community-level receptors in mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	8,610	7,318	87	**99**	**84**	--	--	--	--	--	--	--	--
Beryllium (dissolved	1.3	1.2	0.7	**2.0**	**1.8**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	5.5	5.3	--	--	--	334	477	1.05	1.37	**5.3**	**5.1**	**4.0**	**3.9**
Copper (dissolved)	119	107	--	--	--	334	477	25.1	34.0	**4.7**	**4.3**	**3.5**	**3.1**
Iron (total)	21,700	17,150	1,000	**22**	**17**	--	--	--	--	--	--	--	--
Lead (dissolved)	15.1	14.2	--	--	--	334	477	9.1	13.1	**1.7**	**1.6**	**1.2**	**1.1**
Manganese (dissolved)	5,290	4,618	--	--	--	334	477	2465	2776	**2.1**	**1.9**	**1.9**	**1.7**
Zinc (dissolved)	2,670	2,303	--	--	--	334	477	363	502	**7.4**	**6.3**	**5.3**	**4.6**
RUNOFF PERIOD													
Aluminum (total)	2,876	2,389	87	**33**	**27**	--	--	--	--	--	--	--	--
Beryllium (dissolved)	1.0	0.7	0.7	**1.5**	**1.1**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	3.3	2.8	--	--	--	91	124	0.39	0.50	**8.4**	**7.1**	**6.7**	**5.6**
Copper (dissolved)	78.1	68.6	--	--	--	91	124	8.3	10.8	**9.5**	**8.3**	**7.3**	**6.4**
Iron (total)	12,554	8,067	1,000	**13**	**8.1**	--	--	--	--	--	--	--	--
Lead (dissolved)	10.4	8.4	--	--	--	91	124	2.3	3.2	**4.6**	**3.7**	**3.3**	**2.6**
Manganese (dissolved)	1,620	1,268	--	--	--	91	124	1599	1772	**1.01**	<1	<1	<1
Zinc (dissolved)	1,144	929	--	--	--	91	124	111	147	**10**	**8.4**	**7.8**	**6.3**
POST-RUNOFF PERIOD													
Aluminum (total)	7,110	6,360	87	**82**	**73**	--	--	--	--	--	--	--	--
Beryllium (dissolved)	1.0	1.1	0.7	**1.5**	**1.7**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	6.1	5.6	--	--	--	343	409	1.07	1.22	**5.7**	**5.3**	**5.0**	**4.6**
Copper (dissolved)	152	130	--	--	--	343	409	25.7	29.8	**5.9**	**5.1**	**5.1**	**4.4**
Iron (total)	12,725	10,801	1,000	**13**	**11**	--	--	--	--	--	--	--	--
Lead (dissolved)	17.1	15.5	--	--	--	343	409	9.3	11.2	**1.8**	**1.7**	**1.5**	**1.4**
Manganese (dissolved)	5,300	4,112	--	--	--	343	409	2487	2637	**2.1**	**1.7**	**2.0**	**1.6**
Zinc (dissolved)	2,890	2,190	--	--	--	343	409	372	436	**7.8**	**5.9**	**6.6**	**5.0**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.22
Surface water HQs for aquatic community-level receptors in the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	401	305	87	**4.6**	**3.5**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	3.6	2.6	--	--	--	148	170	0.57	0.63	**6.3**	**4.7**	**5.7**	**4.2**
Copper (dissolved)	8.3	7.2	--	--	--	148	170	12.5	14.1	<1	<1	<1	<1
Iron (total)	309	259	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	0.5	0.4	--	--	--	148	170	3.8	4.5	<1	<1	<1	<1
Manganese (dissolved)	3,676	3,300	--	--	--	148	170	1880	1969	**2.0**	**1.8**	**1.9**	**1.7**
Zinc (dissolved)	1,012	840	--	--	--	148	170	173	196	**5.8**	**4.9**	**5.2**	**4.3**
RUNOFF PERIOD													
Aluminum (total)	566	480	87	**6.5**	**5.5**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.1	1.0	--	--	--	64	69	0.30	0.32	**3.8**	**3.5**	**3.6**	**3.3**
Copper (dissolved)	11.3	10.0	--	--	--	64	69	6.1	6.5	**1.8**	**1.6**	**1.7**	**1.5**
Iron (total)	556	469	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	1.1	1.0	--	--	--	64	69	1.5	1.7	<1	<1	<1	<1
Manganese (dissolved)	633	514	--	--	--	64	69	1422	1458	<1	<1	<1	<1
Zinc (dissolved)	381	344	--	--	--	64	69	81	86	**4.7**	**4.3**	**4.4**	**4.0**
POST-RUNOFF PERIOD													
Aluminum (total)	154	153	87	**1.8**	**1.8**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.2	1.1	--	--	--	112	124	0.46	0.50	**2.6**	**2.4**	**2.4**	**2.2**
Copper (dissolved)	3.2	3.2	--	--	--	112	124	9.9	10.8	<1	<1	<1	<1
Iron (total)	149	154	1,000	<1	<1	--	--	--	--	--	--	--	--
Lead (dissolved)	0.3	0.3	--	--	--	112	124	2.8	3.2	<1	<1	<1	<1
Manganese (dissolved)	1,247	1,031	--	--	--	112	124	1713	1772	<1	<1	<1	<1
Zinc (dissolved)	362	327	--	--	--	112	124	134	147	**2.7**	**2.4**	**2.5**	**2.2**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)

Table 5.23
Surface water HQs for aquatic community-level receptors in the Animas River between the mainstems of Cement Creek and Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
POST-RUNOFF PERIOD													
Aluminum (total)	2,520	2,490	87	**29**	**29**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	2.7	2.7	--	--	--	295	296	0.95	0.95	**2.8**	**2.8**	**2.8**	**2.8**
Copper (dissolved)	24.8	20.6	--	--	--	295	296	22.6	22.6	**1.1**	<1	**1.1**	<1
Iron (total)	5,100	4,995	1,000	**5.1**	**5.0**	--	--	--	--	--	--	--	--
Manganese (dissolved)	2,590	2,565	--	--	--	295	296	2365	2368	**1.1**	**1.1**	**1.1**	**1.1**
Zinc (dissolved)	1,160	1,160	--	--	--	295	296	324	325	**3.6**	**3.6**	**3.6**	**3.6**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.24
Surface water HQs for aquatic community-level receptors at sampling location A71B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
POST-RUNOFF PERIOD													
Aluminum (total)	2,780	2,780	87	**32**	**32**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.9	--	--	--	263	263	0.87	0.87	**2.2**	**2.2**	**2.2**	**2.2**
Copper (dissolved)	8.7	8.7	--	--	--	263	263	20.5	20.5	<1	<1	<1	<1
Iron (total)	4,640	4,640	1,000	**4.6**	**4.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,660	1,660	--	--	--	263	263	2276	2276	<1	<1	<1	<1
Zinc (dissolved)	743	743	--	--	--	263	263	292	292	**2.5**	**2.5**	**2.5**	**2.5**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.25
Surface water HQs for aquatic community-level receptors at sampling location A72 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD													
Aluminum (total)	4,440	3,455	87	**51**	**40**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	2.9	2.7	--	--	--	192	285	0.69	0.93	**4.2**	**3.9**	**3.1**	**2.9**
Copper (dissolved)	35.9	28.9	--	--	--	192	285	15.6	21.9	**2.3**	**1.8**	**1.6**	**1.3**
Iron (total)	7,710	6,018	1,000	**7.7**	**6.0**	--	--	--	--	--	--	--	--
Manganese (dissolved)	2,920	2,435	--	--	--	192	285	2050	2338	**1.4**	**1.2**	**1.2**	**1.04**
Zinc (dissolved)	1,230	1,044	--	--	--	192	285	219	314	**5.6**	**4.8**	**3.9**	**3.3**
RUNOFF PERIOD													
Aluminum (total)	2,065	1,359	87	**24**	**16**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.9	--	--	--	56	72	0.27	0.33	**3.7**	**3.2**	**3.0**	**2.7**
Copper (dissolved)	6.7	5.2	--	--	--	56	72	5.5	6.8	**1.2**	<1	<1	<1
Iron (total)	4,687	2,905	1,000	**4.7**	**2.9**	--	--	--	--	--	--	--	--
Manganese (dissolved)	578	427	--	--	--	56	72	1360	1479	<1	<1	<1	<1
Zinc (dissolved)	352	273	--	--	--	56	72	72	90	**4.9**	**3.8**	**3.9**	**3.0**
POST-RUNOFF PERIOD													
Aluminum (total)	2,129	1,777	87	**24**	**20**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.9	1.6	--	--	--	158	189	0.60	0.68	**3.1**	**2.7**	**2.7**	**2.3**
Copper (dissolved)	17	14	--	--	--	158	189	13.2	15.4	**1.3**	**1.1**	**1.1**	<1
Iron (total)	3,409	2,701	1,000	**3.4**	**2.7**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,514	1,242	--	--	--	158	189	1921	2039	<1	<1	<1	<1
Zinc (dissolved)	696	579	--	--	--	158	189	184	216	**3.8**	**3.2**	**3.2**	**2.7**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.26
Surface water HQs for aquatic community-level receptors at sampling location A73 in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	2,030	1,461	87	**23**	**17**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.7	1.3	--	--	--	77	147	0.35	0.56	**4.9**	**3.6**	**3.0**	**2.2**
Copper (dissolved)	5.0	3.7	--	--	--	77	147	7.2	12.4	<1	<1	<1	<1
Iron (total)	4,163	2,986	1,000	**4**	**3**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,592	1,009	--	--	--	77	147	1512	1875	**1.05**	<1	<1	<1
Zinc (dissolved)	666	463	--	--	--	77	147	96	172	**7.0**	**4.8**	**3.9**	**2.7**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.27
Surface water HQs for aquatic community-level receptors at sampling location A73B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,764	975	87	**20**	**11**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.3	0.7	--	--	--	37	98	0.20	0.42	**6.4**	**3.6**	**3.1**	**1.7**
Copper (dissolved)	3.8	2.6	--	--	--	37	98	3.8	8.8	**1.0**	<1	<1	<1
Iron (total)	2,649	1,570	1,000	**2.6**	**1.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	1,079	508	--	--	--	37	98	1185	1639	<1	<1	<1	<1
Zinc (dissolved)	500	250	--	--	--	37	98	49	119	**10**	**5.1**	**4.2**	**2.1**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.28
Surface water HQs for aquatic community-level receptors at sampling location A75D in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,728	1,255	87	**20**	**14**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.8	--	--	--	60	110	0.29	0.45	**3.6**	**2.7**	**2.3**	**1.7**
Copper (dissolved)	3.9	2.5	--	--	--	60	110	5.8	9.7	<1	<1	<1	<1
Iron (total)	3,922	2,556	1,000	**3.9**	**2.6**	--	--	--	--	--	--	--	--
Manganese (dissolved)	935	590	--	--	--	60	110	1391	1703	<1	<1	<1	<1
Zinc (dissolved)	384	261	--	--	--	60	110	76	132	**5.0**	**3.4**	**2.9**	**2.0**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.29
Surface water HQs for aquatic community-level receptors at sampling location A75B in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,565	1,021	87	**18**	**12**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	1.0	0.7	--	--	--	61	102	0.29	0.43	**3.5**	**2.4**	**2.4**	**1.6**
Copper (dissolved)	4.1	2.6	--	--	--	61	102	5.9	9.1	<1	<1	<1	<1
Iron (total)	4,454	2,224	1,000	**4.5**	**2.2**	61	--	--	--	--	--	--	--
Manganese (dissolved)	782	462	--	--	--	61	102	1399	1661	<1	<1	<1	<1
Zinc (dissolved)	402	235	--	--	--	61	102	77	123	**5.2**	**3.0**	**3.3**	**1.9**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.30
Surface water HQs for aquatic community-level receptors at Bakers Bridge sampling location in the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas River Mining District

COPECs	Surface Water EPCs (µg/L)		Benchmark	HQ		Hardness (mg/L)		Hardn. Adj. Benchm.		Low Hardness		High Hardness	
	RME	CTE	(µg/L)	RME	CTE	low	average	low	average	HQ RME	HQ CTE	HQ RME	HQ CTE
PRE-RUNOFF PERIOD (n=1) RUNOFF PERIOD (n = 2) and POST-RUNOFF PERIOD (n = 2) COMBINED													
Aluminum (total)	1,103	704	87	**13**	**8.1**	--	--	--	--	--	--	--	--
Cadmium (dissolved)	0.6	0.5	--	--	--	61	108	0.29	0.45	**2.1**	**1.6**	**1.4**	**1.03**
Copper (dissolved)	3.7	2.9	--	--	--	61	108	5.9	9.6	<1	<1	<1	<1
Iron (total)	2,742	1,717	1,000	**2.7**	**1.7**	--	--	--	--	--	--	--	--
Manganese (dissolved)	543	356	--	--	--	61	108	1399	1692	<1	<1	<1	<1
Zinc (dissolved)	204	136	--	--	--	61	108	77	130	**2.6**	**1.8**	**1.6**	**1.05**

ug/L = microgram per liter
mg/L = milligram per liter
CTE = central tendency exposure
COPEC = contaminant of potential ecological concern
EPC = exposure point concentration
HQ = hazard quotient (concentration/benchmark)
RME = reasonable maximum exposure

prepared by: SJP (1/31/14)
reviewed by: RI (2/10/14)
updated by: EC (3/6/15)
reviewed by: BB (3/6/15)

Table 5.31
HQs for the American dipper foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	4.85E-01	2.24	4.51	<1	<1	3.07E-01	2.24	4.51	<1	<1
Cadmium	7.84E-01	1.47	6.35	<1	<1	5.80E-01	1.47	6.35	<1	<1
Chromium	5.54E-01	2.66	15.6	<1	<1	5.11E-01	2.66	15.6	<1	<1
Copper	1.36E+01	4.05	34.9	**3.4**	<1	1.30E+01	4.05	34.9	**3.2**	<1
Lead	8.70E+00	1.63	44.6	**5.3**	<1	7.45E+00	1.63	44.6	**4.6**	<1
Mercury	1.74E-02	0.45	0.9	<1	<1	1.68E-02	0.45	0.9	<1	<1
Nickel	1.21E-01	6.71	18.6	<1	<1	1.19E-01	6.71	18.6	<1	<1
Selenium	1.75E-01	0.29	0.82	<1	<1	1.76E-01	0.29	0.82	<1	<1
Silver	5.69E-02	2.02	60.5	<1	<1	5.34E-02	2.02	60.5	<1	<1
Zinc	1.65E+02	66.1	171	**2.5**	<1	1.20E+02	66.1	171	**1.8**	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.32
HQs for the American dipper foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.39E-01	2.24	4.51	<1	<1	1.25E-01	2.24	4.51	<1	<1
Cadmium	1.39E-01	1.47	6.35	<1	<1	1.38E-01	1.47	6.35	<1	<1
Chromium	4.36E-01	2.66	15.6	<1	<1	4.33E-01	2.66	15.6	<1	<1
Copper	7.87E+00	4.05	34.9	**1.9**	<1	7.79E+00	4.05	34.9	**1.9**	<1
Lead	2.75E+00	1.63	44.6	**1.7**	<1	2.52E+00	1.63	44.6	**1.5**	<1
Mercury	2.11E-02	0.45	0.9	<1	<1	2.11E-02	0.45	0.9	<1	<1
Nickel	6.54E-02	6.71	18.6	<1	<1	6.39E-02	6.71	18.6	<1	<1
Selenium	1.09E-01	0.29	0.82	<1	<1	1.08E-01	0.29	0.82	<1	<1
Silver	5.72E-02	2.02	60.5	<1	<1	5.62E-02	2.02	60.5	<1	<1
Zinc	3.44E+01	66.1	171	<1	<1	3.40E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.33
HQs for the American dipper foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	2.09E-01	2.24	4.51	<1	<1	1.96E-01	2.24	4.51	<1	<1
Cadmium	1.95E-01	1.47	6.35	<1	<1	1.92E-01	1.47	6.35	<1	<1
Chromium	4.09E-01	2.66	15.6	<1	<1	4.06E-01	2.66	15.6	<1	<1
Copper	7.12E+00	4.05	34.9	**1.8**	<1	6.93E+00	4.05	34.9	**1.7**	<1
Lead	2.90E+00	1.63	44.6	**1.8**	<1	2.43E+00	1.63	44.6	**1.5**	<1
Mercury	2.16E-02	0.45	0.9	<1	<1	2.16E-02	0.45	0.9	<1	<1
Nickel	1.29E-01	6.71	18.6	<1	<1	1.27E-01	6.71	18.6	<1	<1
Selenium	1.10E-01	0.29	0.82	<1	<1	1.10E-01	0.29	0.82	<1	<1
Silver	5.99E-02	2.02	60.5	<1	<1	5.79E-02	2.02	60.5	<1	<1
Zinc	4.18E+01	66.1	171	<1	<1	4.10E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.34
HQs for the American dipper foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.68E+00	2.24	4.51	<1	<1	1.36E+00	2.24	4.51	<1	<1
Cadmium	2.08E-01	1.47	6.35	<1	<1	1.88E-01	1.47	6.35	<1	<1
Chromium	5.81E-01	2.66	15.6	<1	<1	5.59E-01	2.66	15.6	<1	<1
Copper	4.77E+01	4.05	34.9	**12**	**1.4**	2.89E+01	4.05	34.9	**7.1**	<1
Lead	5.15E+00	1.63	44.6	**3.2**	<1	4.77E+00	1.63	44.6	**2.9**	<1
Mercury	2.11E-02	0.45	0.9	<1	<1	1.64E-02	0.45	0.9	<1	<1
Nickel	4.28E-01	6.71	18.6	<1	<1	3.74E-01	6.71	18.6	<1	<1
Selenium	5.73E-01	0.29	0.82	**2.0**	<1	5.73E-01	0.29	0.82	**2.0**	<1
Silver	1.16E-01	2.02	60.5	<1	<1	7.48E-02	2.02	60.5	<1	<1
Zinc	4.26E+01	66.1	171	<1	<1	3.92E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.35
HQs for the American dipper foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.79E-01	2.24	4.51	<1	<1	1.62E-01	2.24	4.51	<1	<1
Cadmium	1.67E-01	1.47	6.35	<1	<1	1.64E-01	1.47	6.35	<1	<1
Chromium	6.48E-01	2.66	15.6	<1	<1	6.46E-01	2.66	15.6	<1	<1
Copper	3.41E+00	4.05	34.9	<1	<1	3.27E+00	4.05	34.9	<1	<1
Lead	1.25E+00	1.63	44.6	<1	<1	1.10E+00	1.63	44.6	<1	<1
Mercury	4.80E-02	0.45	0.9	<1	<1	4.80E-02	0.45	0.9	<1	<1
Nickel	1.47E-01	6.71	18.6	<1	<1	1.40E-01	6.71	18.6	<1	<1
Selenium	2.42E-01	0.29	0.82	<1	<1	2.42E-01	0.29	0.82	<1	<1
Silver	1.23E-01	2.02	60.5	<1	<1	1.22E-01	2.02	60.5	<1	<1
Zinc	4.27E+01	66.1	171	<1	<1	4.04E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.36
HQs for the American dipper foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.61E+00	2.24	4.51	<1	<1	9.95E-01	2.24	4.51	<1	<1
Cadmium	3.40E-01	1.47	6.35	<1	<1	2.28E-01	1.47	6.35	<1	<1
Chromium	6.02E-01	2.66	15.6	<1	<1	5.89E-01	2.66	15.6	<1	<1
Copper	6.75E+01	4.05	34.9	**17**	**1.9**	3.07E+01	4.05	34.9	**7.6**	<1
Lead	4.11E+00	1.63	44.6	**2.5**	<1	3.10E+00	1.63	44.6	**1.9**	<1
Mercury	1.64E-02	0.45	0.9	<1	<1	1.64E-02	0.45	0.9	<1	<1
Nickel	5.34E-01	6.71	18.6	<1	<1	3.66E-01	6.71	18.6	<1	<1
Selenium	6.53E-01	0.29	0.82	**2.3**	<1	3.76E-01	0.29	0.82	**1.3**	<1
Silver	8.22E-02	2.02	60.5	<1	<1	5.23E-02	2.02	60.5	<1	<1
Zinc	5.64E+01	66.1	171	<1	<1	4.48E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.37
HQs for the American dipper foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.10E-01	2.24	4.51	<1	<1	9.28E-02	2.24	4.51	<1	<1
Cadmium	3.52E-01	1.47	6.35	<1	<1	3.33E-01	1.47	6.35	<1	<1
Chromium	4.16E-01	2.66	15.6	<1	<1	4.12E-01	2.66	15.6	<1	<1
Copper	4.16E+00	4.05	34.9	**1.03**	<1	3.85E+00	4.05	34.9	<1	<1
Lead	1.32E+00	1.63	44.6	<1	<1	1.15E+00	1.63	44.6	<1	<1
Mercury	1.83E-02	0.45	0.9	<1	<1	1.83E-02	0.45	0.9	<1	<1
Nickel	3.78E-01	6.71	18.6	<1	<1	3.50E-01	6.71	18.6	<1	<1
Selenium	9.77E-02	0.29	0.82	<1	<1	9.55E-02	0.29	0.82	<1	<1
Silver	4.89E-02	2.02	60.5	<1	<1	4.80E-02	2.02	60.5	<1	<1
Zinc	8.76E+01	66.1	171	**1.3**	<1	7.91E+01	66.1	171	**1.2**	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/8/14
updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.38
HQs for the mallard foraging on the Animas River above mainstem Cement Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.08E-01	2.24	4.51	<1	<1	6.50E-02	2.24	4.51	<1	<1
Cadmium	1.97E-01	1.47	6.35	<1	<1	1.45E-01	1.47	6.35	<1	<1
Chromium	1.41E-01	2.66	15.6	<1	<1	1.30E-01	2.66	15.6	<1	<1
Copper	3.31E+00	4.05	34.9	<1	<1	3.18E+00	4.05	34.9	<1	<1
Lead	1.32E+00	1.63	44.6	<1	<1	1.12E+00	1.63	44.6	<1	<1
Mercury	4.48E-03	0.45	0.9	<1	<1	4.32E-03	0.45	0.9	<1	<1
Nickel	2.64E-02	6.71	18.6	<1	<1	2.64E-02	6.71	18.6	<1	<1
Selenium	4.49E-02	0.29	0.82	<1	<1	4.49E-02	0.29	0.82	<1	<1
Silver	1.13E-02	2.02	60.5	<1	<1	1.09E-02	2.02	60.5	<1	<1
Zinc	4.08E+01	66.1	171	<1	<1	2.96E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by: EC 3/01/15
QC'd by: RI 3/3/15

Table 5.39
HQs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.46E-02	2.24	4.51	<1	<1	1.43E-02	2.24	4.51	<1	<1
Cadmium	3.47E-02	1.47	6.35	<1	<1	3.47E-02	1.47	6.35	<1	<1
Chromium	1.10E-01	2.66	15.6	<1	<1	1.10E-01	2.66	15.6	<1	<1
Copper	1.95E+00	4.05	34.9	<1	<1	1.95E+00	4.05	34.9	<1	<1
Lead	3.98E-01	1.63	44.6	<1	<1	3.95E-01	1.63	44.6	<1	<1
Mercury	5.44E-03	0.45	0.9	<1	<1	5.44E-03	0.45	0.9	<1	<1
Nickel	1.39E-02	6.71	18.6	<1	<1	1.39E-02	6.71	18.6	<1	<1
Selenium	2.72E-02	0.29	0.82	<1	<1	2.72E-02	0.29	0.82	<1	<1
Silver	1.36E-02	2.02	60.5	<1	<1	1.36E-02	2.02	60.5	<1	<1
Zinc	8.51E+00	66.1	171	<1	<1	8.50E+00	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.40
HQs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.60E-02	2.24	4.51	<1	<1	3.58E-02	2.24	4.51	<1	<1
Cadmium	4.78E-02	1.47	6.35	<1	<1	4.78E-02	1.47	6.35	<1	<1
Chromium	1.03E-01	2.66	15.6	<1	<1	1.03E-01	2.66	15.6	<1	<1
Copper	1.70E+00	4.05	34.9	<1	<1	1.70E+00	4.05	34.9	<1	<1
Lead	3.59E-01	1.63	44.6	<1	<1	3.53E-01	1.63	44.6	<1	<1
Mercury	5.60E-03	0.45	0.9	<1	<1	5.60E-03	0.45	0.9	<1	<1
Nickel	2.97E-02	6.71	18.6	<1	<1	2.96E-02	6.71	18.6	<1	<1
Selenium	2.80E-02	0.29	0.82	<1	<1	2.79E-02	0.29	0.82	<1	<1
Silver	1.40E-02	2.02	60.5	<1	<1	1.40E-02	2.02	60.5	<1	<1
Zinc	1.01E+01	66.1	171	<1	<1	1.01E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.41
HQs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	4.15E-01	2.24	4.51	<1	<1	3.37E-01	2.24	4.51	<1	<1
Cadmium	5.17E-02	1.47	6.35	<1	<1	4.71E-02	1.47	6.35	<1	<1
Chromium	1.49E-01	2.66	15.6	<1	<1	1.43E-01	2.66	15.6	<1	<1
Copper	1.22E+01	4.05	34.9	**3.0**	<1	7.42E+00	4.05	34.9	**1.8**	<1
Lead	1.02E+00	1.63	44.6	<1	<1	9.50E-01	1.63	44.6	<1	<1
Mercury	6.03E-02	0.45	0.9	<1	<1	6.03E-02	0.45	0.9	<1	<1
Nickel	1.05E-01	6.71	18.6	<1	<1	9.19E-02	6.71	18.6	<1	<1
Selenium	1.48E-01	0.29	0.82	<1	<1	1.48E-01	0.29	0.82	<1	<1
Silver	2.84E-02	2.02	60.5	<1	<1	1.84E-02	2.02	60.5	<1	<1
Zinc	1.02E+01	66.1	171	<1	<1	9.59E+00	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.42
HQs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.17E-02	2.24	4.51	<1	<1	3.16E-02	2.24	4.51	<1	<1
Cadmium	4.00E-02	1.47	6.35	<1	<1	4.00E-02	1.47	6.35	<1	<1
Chromium	1.66E-01	2.66	15.6	<1	<1	1.66E-01	2.66	15.6	<1	<1
Copper	7.71E-01	4.05	34.9	<1	<1	7.69E-01	4.05	34.9	<1	<1
Lead	1.26E-01	1.63	44.6	<1	<1	1.24E-01	1.63	44.6	<1	<1
Mercury	1.25E-02	0.45	0.9	<1	<1	1.25E-02	0.45	0.9	<1	<1
Nickel	3.14E-02	6.71	18.6	<1	<1	3.14E-02	6.71	18.6	<1	<1
Selenium	6.23E-02	0.29	0.82	<1	<1	6.23E-02	0.29	0.82	<1	<1
Silver	3.12E-02	2.02	60.5	<1	<1	3.12E-02	2.02	60.5	<1	<1
Zinc	9.60E+00	66.1	171	<1	<1	9.57E+00	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.43
HQs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.98E-01	2.24	4.51	<1	<1	2.48E-01	2.24	4.51	<1	<1
Cadmium	8.27E-02	1.47	6.35	<1	<1	5.65E-02	1.47	6.35	<1	<1
Chromium	1.54E-01	2.66	15.6	<1	<1	1.50E-01	2.66	15.6	<1	<1
Copper	1.73E+01	4.05	34.9	**4.28**	<1	7.88E+00	4.05	34.9	**1.95**	<1
Lead	8.32E-01	1.63	44.6	<1	<1	6.45E-01	1.63	44.6	<1	<1
Mercury	6.03E-02	0.45	0.9	<1	<1	6.03E-02	0.45	0.9	<1	<1
Nickel	1.30E-01	6.71	18.6	<1	<1	8.98E-02	6.71	18.6	<1	<1
Selenium	1.68E-01	0.29	0.82	<1	<1	9.67E-02	0.29	0.82	<1	<1
Silver	2.02E-02	2.02	60.5	<1	<1	1.28E-02	2.02	60.5	<1	<1
Zinc	1.18E+01	66.1	171	<1	<1	1.05E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.44
HQs for mallards foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek (100% benthic invert diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.24E-02	2.24	4.51	<1	<1	1.22E-02	2.24	4.51	<1	<1
Cadmium	8.14E-02	1.47	6.35	<1	<1	8.12E-02	1.47	6.35	<1	<1
Chromium	1.04E-01	2.66	15.6	<1	<1	1.04E-01	2.66	15.6	<1	<1
Copper	9.02E-01	4.05	34.9	<1	<1	8.99E-01	4.05	34.9	<1	<1
Lead	1.38E-01	1.63	44.6	<1	<1	1.36E-01	1.63	44.6	<1	<1
Mercury	4.73E-03	0.45	0.9	<1	<1	4.73E-03	0.45	0.9	<1	<1
Nickel	8.14E-02	6.71	18.6	<1	<1	8.11E-02	6.71	18.6	<1	<1
Selenium	2.37E-02	0.29	0.82	<1	<1	2.37E-02	0.29	0.82	<1	<1
Silver	1.18E-02	2.02	60.5	<1	<1	1.18E-02	2.02	60.5	<1	<1
Zinc	1.81E+01	66.1	171	<1	<1	1.81E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
Reviewed by: SJP 2/13/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.45
HQs for Mallard foraging on the Animas River above mainstem Cement Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	7.96E-02	2.24	4.51	<1	<1	5.52E-02	2.24	4.51	<1	<1
Cadmium	1.62E-01	1.47	6.35	<1	<1	1.31E-01	1.47	6.35	<1	<1
Chromium	7.59E-02	2.66	15.6	<1	<1	7.01E-02	2.66	15.6	<1	<1
Copper	2.19E+00	4.05	34.9	<1	<1	2.09E+00	4.05	34.9	<1	<1
Lead	1.12E+00	1.63	44.6	<1	<1	9.84E-01	1.63	44.6	<1	<1
Mercury	4.92E-03	0.45	0.9	<1	<1	4.37E-03	0.45	0.9	<1	<1
Nickel	2.78E-02	6.71	18.6	<1	<1	2.66E-02	6.71	18.6	<1	<1
Selenium	3.53E-02	0.29	0.82	<1	<1	4.27E-02	0.29	0.82	<1	<1
Silver	8.01E-03	2.02	60.5	<1	<1	7.46E-03	2.02	60.5	<1	<1
Zinc	3.28E+01	66.1	171	<1	<1	2.56E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.46
HQs for mallards foraging at sampling location A72 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.55E-02	2.24	4.51	<1	<1	3.26E-02	2.24	4.51	<1	<1
Cadmium	4.57E-02	1.47	6.35	<1	<1	4.11E-02	1.47	6.35	<1	<1
Chromium	6.14E-02	2.66	15.6	<1	<1	5.98E-02	2.66	15.6	<1	<1
Copper	1.36E+00	4.05	34.9	<1	<1	1.32E+00	4.05	34.9	<1	<1
Lead	4.46E-01	1.63	44.6	<1	<1	4.18E-01	1.63	44.6	<1	<1
Mercury	4.93E-03	0.45	0.9	<1	<1	4.76E-03	0.45	0.9	<1	<1
Nickel	1.75E-02	6.71	18.6	<1	<1	1.65E-02	6.71	18.6	<1	<1
Selenium	3.98E-02	0.29	0.82	<1	<1	3.38E-02	0.29	0.82	<1	<1
Silver	7.67E-03	2.02	60.5	<1	<1	7.48E-03	2.02	60.5	<1	<1
Zinc	9.37E+00	66.1	171	<1	<1	8.75E+00	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.47
HQs for mallards foraging at sampling location A73 on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	4.36E-02	2.24	4.51	<1	<1	4.09E-02	2.24	4.51	<1	<1
Cadmium	6.37E-02	1.47	6.35	<1	<1	5.76E-02	1.47	6.35	<1	<1
Chromium	5.74E-02	2.66	15.6	<1	<1	5.59E-02	2.66	15.6	<1	<1
Copper	1.31E+00	4.05	34.9	<1	<1	1.25E+00	4.05	34.9	<1	<1
Lead	4.60E-01	1.63	44.6	<1	<1	4.06E-01	1.63	44.6	<1	<1
Mercury	4.64E-03	0.45	0.9	<1	<1	4.43E-03	0.45	0.9	<1	<1
Nickel	2.71E-02	6.71	18.6	<1	<1	2.60E-02	6.71	18.6	<1	<1
Selenium	3.27E-02	0.29	0.82	<1	<1	2.83E-02	0.29	0.82	<1	<1
Silver	8.05E-03	2.02	60.5	<1	<1	7.71E-03	2.02	60.5	<1	<1
Zinc	1.19E+01	66.1	171	<1	<1	1.09E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.48
HQs for mallards foraging at sampling location A73B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	2.36E-01	2.24	4.51	<1	<1	1.92E-01	2.24	4.51	<1	<1
Cadmium	6.05E-02	1.47	6.35	<1	<1	5.49E-02	1.47	6.35	<1	<1
Chromium	7.97E-02	2.66	15.6	<1	<1	7.64E-02	2.66	15.6	<1	<1
Copper	6.59E+00	4.05	34.9	**1.6**	<1	4.09E+00	4.05	34.9	**1.01**	<1
Lead	7.58E-01	1.63	44.6	<1	<1	7.09E-01	1.63	44.6	<1	<1
Mercury	3.27E-02	0.45	0.9	<1	<1	3.24E-02	0.45	0.9	<1	<1
Nickel	7.04E-02	6.71	18.6	<1	<1	6.15E-02	6.71	18.6	<1	<1
Selenium	1.16E-01	0.29	0.82	<1	<1	1.16E-01	0.29	0.82	<1	<1
Silver	1.54E-02	2.02	60.5	<1	<1	9.91E-03	2.02	60.5	<1	<1
Zinc	1.28E+01	66.1	171	<1	<1	1.08E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.49
HQs for mallards foraging at sampling location A75D on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.84E-02	2.24	4.51	<1	<1	3.45E-02	2.24	4.51	<1	<1
Cadmium	6.37E-02	1.47	6.35	<1	<1	5.73E-02	1.47	6.35	<1	<1
Chromium	8.80E-02	2.66	15.6	<1	<1	8.73E-02	2.66	15.6	<1	<1
Copper	7.98E-01	4.05	34.9	<1	<1	7.41E-01	4.05	34.9	<1	<1
Lead	2.52E-01	1.63	44.6	<1	<1	2.31E-01	1.63	44.6	<1	<1
Mercury	7.86E-03	0.45	0.9	<1	<1	7.86E-03	0.45	0.9	<1	<1
Nickel	3.39E-02	6.71	18.6	<1	<1	3.05E-02	6.71	18.6	<1	<1
Selenium	4.99E-02	0.29	0.82	<1	<1	4.69E-02	0.29	0.82	<1	<1
Silver	1.61E-02	2.02	60.5	<1	<1	1.60E-02	2.02	60.5	<1	<1
Zinc	1.49E+01	66.1	171	<1	<1	1.25E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.50
HQs for mallards foraging at sampling location A75B on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	2.26E-01	2.24	4.51	<1	<1	1.43E-01	2.24	4.51	<1	<1
Cadmium	9.86E-02	1.47	6.35	<1	<1	6.64E-02	1.47	6.35	<1	<1
Chromium	8.25E-02	2.66	15.6	<1	<1	8.07E-02	2.66	15.6	<1	<1
Copper	9.20E+00	4.05	34.9	**2.3**	<1	4.33E+00	4.05	34.9	**1.1**	<1
Lead	6.25E-01	1.63	44.6	<1	<1	4.90E-01	1.63	44.6	<1	<1
Mercury	3.24E-02	0.45	0.9	<1	<1	3.24E-02	0.45	0.9	<1	<1
Nickel	8.75E-02	6.71	18.6	<1	<1	6.00E-02	6.71	18.6	<1	<1
Selenium	1.32E-01	0.29	0.82	<1	<1	7.46E-02	0.29	0.82	<1	<1
Silver	1.09E-02	2.02	60.5	<1	<1	6.94E-03	2.02	60.5	<1	<1
Zinc	2.03E+01	66.1	171	<1	<1	1.40E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.51
HQs for mallards foraging at the Bakers Bridge sampling location on the Animas River below mainstem Mineral Creek (50%-50% diet)
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario Total EDD (mg/kg bw-day)	RME TRV NOAEL	RME TRV LOAEL	RME No Effect HQ	RME Effect HQ	CTE Scenario Total EDD (mg/kg bw-day)	CTE TRV NOAEL	CTE TRV LOAEL	CTE No Effect HQ	CTE Effect HQ
Arsenic	3.00E-02	2.24	4.51	<1	<1	2.61E-02	2.24	4.51	<1	<1
Cadmium	1.19E-01	1.47	6.35	<1	<1	9.66E-02	1.47	6.35	<1	<1
Chromium	5.95E-02	2.66	15.6	<1	<1	5.78E-02	2.66	15.6	<1	<1
Copper	9.44E-01	4.05	34.9	<1	<1	8.45E-01	4.05	34.9	<1	<1
Lead	2.61E-01	1.63	44.6	<1	<1	2.36E-01	1.63	44.6	<1	<1
Mercury	4.40E-03	0.45	0.9	<1	<1	4.00E-03	0.45	0.9	<1	<1
Nickel	7.69E-02	6.71	18.6	<1	<1	6.50E-02	6.71	18.6	<1	<1
Selenium	5.69E-02	0.29	0.82	<1	<1	4.12E-02	0.29	0.82	<1	<1
Silver	6.52E-03	2.02	60.5	<1	<1	6.36E-03	2.02	60.5	<1	<1
Zinc	2.79E+01	66.1	171	<1	<1	2.24E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/13/14
Updated by: EC 2/27/15
QC'd by: RI 3/3/15

Table 5.52
HQs for the belted kingfisher foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.68E-01	2.24	4.51	<1	<1	2.95E-01	2.24	4.51	<1	<1
Cadmium	1.81E-01	1.47	6.35	<1	<1	1.56E-01	1.47	6.35	<1	<1
Chromium	1.64E-02	2.66	15.6	<1	<1	8.82E-02	2.66	15.6	<1	<1
Copper	3.41E+00	4.05	34.9	<1	<1	2.90E+00	4.05	34.9	<1	<1
Lead	1.04E+01	1.63	44.6	**6.4**	<1	9.04E+00	1.63	44.6	**5.5**	<1
Mercury	2.77E-02	0.45	0.9	<1	<1	7.77E-04	0.45	0.9	<1	<1
Nickel	7.84E-01	6.71	18.6	<1	<1	3.20E+00	6.71	18.6	<1	<1
Selenium	8.50E-02	0.29	0.82	<1	<1	1.28E-01	0.29	0.82	<1	<1
Silver	5.45E-01	2.02	60.5	<1	<1	4.69E-01	2.02	60.5	<1	<1
Zinc	5.09E+01	66.1	171	<1	<1	3.99E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by : EC 3/1/15
QC'd by: RI 3/3/15

Table 5.53
HQs for the belted kingfisher foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	4.27E-01	2.24	4.51	<1	<1	3.60E-01	2.24	4.51	<1	<1
Cadmium	4.08E-02	1.47	6.35	<1	<1	2.96E-02	1.47	6.35	<1	<1
Chromium	2.00E-02	2.66	15.6	<1	<1	1.50E-02	2.66	15.6	<1	<1
Copper	1.48E+00	4.05	34.9	<1	<1	1.17E+00	4.05	34.9	<1	<1
Lead	3.49E+00	1.63	44.6	**2.1**	<1	2.87E+00	1.63	44.6	**1.8**	<1
Mercury	1.94E-02	0.45	0.9	<1	<1	1.66E-02	0.45	0.9	<1	<1
Nickel	5.03E-01	6.71	18.6	<1	<1	4.35E-01	6.71	18.6	<1	<1
Selenium	1.62E-01	0.29	0.82	<1	<1	1.28E-01	0.29	0.82	<1	<1
Silver	2.04E-01	2.02	60.5	<1	<1	1.62E-01	2.02	60.5	<1	<1
Zinc	1.04E+01	66.1	171	<1	<1	8.24E+00	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.54
HQs for the belted kingfisher foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.64E-01	2.24	4.51	<1	<1	3.00E-01	2.24	4.51	<1	<1
Cadmium	7.58E-02	1.47	6.35	<1	<1	5.62E-02	1.47	6.35	<1	<1
Chromium	1.77E-02	2.66	15.6	<1	<1	1.31E-02	2.66	15.6	<1	<1
Copper	2.43E+00	4.05	34.9	<1	<1	1.70E+00	4.05	34.9	<1	<1
Lead	4.37E+00	1.63	44.6	**2.7**	<1	3.08E+00	1.63	44.6	**1.9**	<1
Mercury	1.38E-02	0.45	0.9	<1	<1	1.11E-02	0.45	0.9	<1	<1
Nickel	6.14E-01	6.71	18.6	<1	<1	5.46E-01	6.71	18.6	<1	<1
Selenium	1.19E-01	0.29	0.82	<1	<1	9.37E-02	0.29	0.82	<1	<1
Silver	2.39E-01	2.02	60.5	<1	<1	1.62E-01	2.02	60.5	<1	<1
Zinc	1.76E+01	66.1	171	<1	<1	1.32E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.55
HQs for the belted kingfisher foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	4.24E-01	2.24	4.51	<1	<1	3.22E-01	2.24	4.51	<1	<1
Cadmium	5.90E-02	1.47	6.35	<1	<1	4.91E-02	1.47	6.35	<1	<1
Chromium	1.70E-02	2.66	15.6	<1	<1	1.54E-02	2.66	15.6	<1	<1
Copper	2.50E+00	4.05	34.9	<1	<1	1.51E+00	4.05	34.9	<1	<1
Lead	3.56E+00	1.63	44.6	**2.2**	<1	3.20E+00	1.63	44.6	**2.0**	<1
Mercury	2.49E-02	0.45	0.9	<1	<1	1.94E-02	0.45	0.9	<1	<1
Nickel	1.03E+00	6.71	18.6	<1	<1	8.52E-01	6.71	18.6	<1	<1
Selenium	2.47E-01	0.29	0.82	<1	<1	2.47E-01	0.29	0.82	<1	<1
Silver	2.64E-01	2.02	60.5	<1	<1	1.70E-01	2.02	60.5	<1	<1
Zinc	2.16E+01	66.1	171	<1	<1	1.40E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.56
HQs for the belted kingfisher foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	2.91E-01	2.24	4.51	<1	<1	2.09E-01	2.24	4.51	<1	<1
Cadmium	8.98E-02	1.47	6.35	<1	<1	6.73E-02	1.47	6.35	<1	<1
Chromium	1.60E-02	2.66	15.6	<1	<1	1.37E-02	2.66	15.6	<1	<1
Copper	1.81E+00	4.05	34.9	<1	<1	1.26E+00	4.05	34.9	<1	<1
Lead	2.20E+00	1.63	44.6	**1.4**	<1	1.80E+00	1.63	44.6	**1.1**	<1
Mercury	1.11E-02	0.45	0.9	<1	<1	1.11E-02	0.45	0.9	<1	<1
Nickel	1.06E+00	6.71	18.6	<1	<1	8.01E-01	6.71	18.6	<1	<1
Selenium	1.19E-01	0.29	0.82	<1	<1	1.02E-01	0.29	0.82	<1	<1
Silver	1.19E-01	2.02	60.5	<1	<1	9.37E-02	2.02	60.5	<1	<1
Zinc	3.49E+01	66.1	171	<1	<1	2.19E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.57
HQsfor the belted kingfisher foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**	**Total EDD (mg/kg bw-day)**	**TRV NOAEL**	**TRV LOAEL**	**No Effect HQ**	**Effect HQ**
Arsenic	4.00E-01	2.24	4.51	<1	<1	2.14E-01	2.24	4.51	<1	<1
Cadmium	1.47E-01	1.47	6.35	<1	<1	7.01E-02	1.47	6.35	<1	<1
Chromium	1.80E-02	2.66	15.6	<1	<1	1.70E-02	2.66	15.6	<1	<1
Copper	3.53E+00	4.05	34.9	<1	<1	1.61E+00	4.05	34.9	<1	<1
Lead	2.61E+00	1.63	44.6	**1.6**	<1	1.78E+00	1.63	44.6	**1.1**	<1
Mercury	1.94E-02	0.45	0.9	<1	<1	1.94E-02	0.45	0.9	<1	<1
Nickel	1.41E+00	6.71	18.6	<1	<1	8.26E-01	6.71	18.6	<1	<1
Selenium	2.81E-01	0.29	0.82	<1	<1	1.62E-01	0.29	0.82	<1	<1
Silver	1.87E-01	2.02	60.5	<1	<1	1.19E-01	2.02	60.5	<1	<1
Zinc	6.68E+01	66.1	171	**1.01**	<1	2.75E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.58
HQs for the belted kingfisher foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

	RME Scenario					CTE Scenario				
COPECs	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	3.20E-01	2.24	4.51	<1	<1	2.36E-01	2.24	4.51	<1	<1
Cadmium	2.61E-01	1.47	6.35	<1	<1	1.41E-01	1.47	6.35	<1	<1
Chromium	2.29E-02	2.66	15.6	<1	<1	1.77E-02	2.66	15.6	<1	<1
Copper	2.84E+00	4.05	34.9	<1	<1	1.63E+00	4.05	34.9	<1	<1
Lead	2.26E+00	1.63	44.6	**1.4**	<1	1.80E+00	1.63	44.6	**1.1**	<1
Mercury	1.66E-02	0.45	0.9	<1	<1	1.11E-02	0.45	0.9	<1	<1
Nickel	2.64E+00	6.71	18.6	<1	<1	1.56E+00	6.71	18.6	<1	<1
Selenium	2.64E-01	0.29	0.82	<1	<1	1.79E-01	0.29	0.82	<1	<1
Silver	1.45E-01	2.02	60.5	<1	<1	1.11E-01	2.02	60.5	<1	<1
Zinc	1.07E+02	66.1	171	**1.6**	<1	5.80E+01	66.1	171	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/29/14
Reviewed by: SJP 2/8/14
Updated by: EC 3/1/15
Qc'd by: RI 3/3/15

Table 5.59
HQs for the muskrat foraging on the Animas River above mainstem Cement Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.04E-01	1.04	4.6	<1	<1	8.96E-02	1.04	4.6	<1	<1
Cadmium	2.01E-01	0.77	6.9	<1	<1	1.84E-01	0.77	6.9	<1	<1
Chromium	1.97E-02	2.4	58.2	<1	<1	1.85E-02	2.4	58.2	<1	<1
Copper	1.90E+00	5.6	82.7	<1	<1	1.75E+00	5.6	82.7	<1	<1
Lead	2.77E+00	4.7	186.4	<1	<1	2.48E+00	4.7	186.4	<1	<1
Mercury	8.05E-03	1	3	<1	<1	6.62E-03	1	3	<1	<1
Nickel	5.07E-02	1.7	14.8	<1	<1	4.63E-02	1.7	14.8	<1	<1
Selenium	3.91E-02	0.14	0.66	<1	<1	6.12E-02	0.14	0.66	<1	<1
Silver	1.21E-02	6.02	119	<1	<1	1.04E-02	6.02	119	<1	<1
Zinc	4.01E+01	75.4	298	<1	<1	3.47E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by: EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.60
HQs for the muskrat foraging at sampling location A72 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.16E-01	1.04	4.6	<1	<1	1.03E-01	1.04	4.6	<1	<1
Cadmium	8.65E-02	0.77	6.9	<1	<1	7.23E-02	0.77	6.9	<1	<1
Chromium	2.40E-02	2.4	58.2	<1	<1	1.81E-02	2.4	58.2	<1	<1
Copper	1.27E+00	5.6	82.7	<1	<1	1.14E+00	5.6	82.7	<1	<1
Lead	1.20E+00	4.7	186.4	<1	<1	1.04E+00	4.7	186.4	<1	<1
Mercury	6.62E-03	1	3	<1	<1	6.09E-03	1	3	<1	<1
Nickel	3.61E-02	1.7	14.8	<1	<1	3.24E-02	1.7	14.8	<1	<1
Selenium	7.95E-02	0.14	0.66	<1	<1	6.12E-02	0.14	0.66	<1	<1
Silver	4.55E-03	6.02	119	<1	<1	3.60E-03	6.02	119	<1	<1
Zinc	1.59E+01	75.4	298	<1	<1	1.39E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.61
HQs for the muskrat foraging at sampling location A73 on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.03E-01	1.04	4.6	<1	<1	9.07E-02	1.04	4.6	<1	<1
Cadmium	1.23E-01	0.77	6.9	<1	<1	1.04E-01	0.77	6.9	<1	<1
Chromium	2.12E-02	2.4	58.2	<1	<1	1.57E-02	2.4	58.2	<1	<1
Copper	1.61E+00	5.6	82.7	<1	<1	1.36E+00	5.6	82.7	<1	<1
Lead	1.42E+00	4.7	186.4	<1	<1	1.09E+00	4.7	186.4	<1	<1
Mercury	5.51E-03	1	3	<1	<1	4.87E-03	1	3	<1	<1
Nickel	4.22E-02	1.7	14.8	<1	<1	3.85E-02	1.7	14.8	<1	<1
Selenium	5.67E-02	0.14	0.66	<1	<1	4.35E-02	0.14	0.66	<1	<1
Silver	5.31E-03	6.02	119	<1	<1	3.60E-03	6.02	119	<1	<1
Zinc	2.15E+01	75.4	298	<1	<1	1.83E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.62
HQs for the muskrat foraging at sampling location A73B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.15E-01	1.04	4.6	<1	<1	9.51E-02	1.04	4.6	<1	<1
Cadmium	1.06E-01	0.77	6.9	<1	<1	9.60E-02	0.77	6.9	<1	<1
Chromium	2.02E-02	2.4	58.2	<1	<1	1.83E-02	2.4	58.2	<1	<1
Copper	1.63E+00	5.6	82.7	<1	<1	1.28E+00	5.6	82.7	<1	<1
Lead	1.22E+00	4.7	186.4	<1	<1	1.13E+00	4.7	186.4	<1	<1
Mercury	7.60E-03	1	3	<1	<1	6.62E-03	1	3	<1	<1
Nickel	6.32E-02	1.7	14.8	<1	<1	5.44E-02	1.7	14.8	<1	<1
Selenium	1.27E-01	0.14	0.66	<1	<1	1.27E-01	0.14	0.66	<1	<1
Silver	5.88E-03	6.02	119	<1	<1	3.79E-03	6.02	119	<1	<1
Zinc	2.43E+01	75.4	298	<1	<1	1.89E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.63
HQs for the muskrat foraging at sampling location A75D on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	8.87E-02	1.04	4.6	<1	<1	7.11E-02	1.04	4.6	<1	<1
Cadmium	1.35E-01	0.77	6.9	<1	<1	1.15E-01	0.77	6.9	<1	<1
Chromium	1.93E-02	2.4	58.2	<1	<1	1.65E-02	2.4	58.2	<1	<1
Copper	1.40E+00	5.6	82.7	<1	<1	1.18E+00	5.6	82.7	<1	<1
Lead	8.60E-01	4.7	186.4	<1	<1	7.44E-01	4.7	186.4	<1	<1
Mercury	4.87E-03	1	3	<1	<1	4.87E-03	1	3	<1	<1
Nickel	6.41E-02	1.7	14.8	<1	<1	5.15E-02	1.7	14.8	<1	<1
Selenium	5.67E-02	0.14	0.66	<1	<1	4.79E-02	0.14	0.66	<1	<1
Silver	2.65E-03	6.02	119	<1	<1	2.09E-03	6.02	119	<1	<1
Zinc	3.21E+01	75.4	298	<1	<1	2.44E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.64
HQs for the muskrat foraging at sampling location A75B on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	1.10E-01	1.04	4.6	<1	<1	7.23E-02	1.04	4.6	<1	<1
Cadmium	1.78E-01	0.77	6.9	<1	<1	1.17E-01	0.77	6.9	<1	<1
Chromium	2.16E-02	2.4	58.2	<1	<1	2.05E-02	2.4	58.2	<1	<1
Copper	1.93E+00	5.6	82.7	<1	<1	1.32E+00	5.6	82.7	<1	<1
Lead	9.72E-01	4.7	186.4	<1	<1	7.37E-01	4.7	186.4	<1	<1
Mercury	6.62E-03	1	3	<1	<1	6.62E-03	1	3	<1	<1
Nickel	8.03E-02	1.7	14.8	<1	<1	5.28E-02	1.7	14.8	<1	<1
Selenium	1.46E-01	0.14	0.66	**1.04**	<1	7.95E-02	0.14	0.66	<1	<1
Silver	4.17E-03	6.02	119	<1	<1	2.65E-03	6.02	119	<1	<1
Zinc	4.72E+01	75.4	298	<1	<1	2.79E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Table 5.65
HQs for the muskrat foraging at the Baker Bridge sampling location on the Animas River below mainstem Mineral Creek
Baseline Ecological Risk Assessment
Upper Animas Mining District

COPECs	RME Scenario					CTE Scenario				
	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Arsenic	9.47E-02	1.04	4.6	<1	<1	7.71E-02	1.04	4.6	<1	<1
Cadmium	2.47E-01	0.77	6.9	<1	<1	1.74E-01	0.77	6.9	<1	<1
Chromium	2.75E-02	2.4	58.2	<1	<1	2.12E-02	2.4	58.2	<1	<1
Copper	1.73E+00	5.6	82.7	<1	<1	1.33E+00	5.6	82.7	<1	<1
Lead	8.74E-01	4.7	186.4	<1	<1	7.43E-01	4.7	186.4	<1	<1
Mercury	6.09E-03	1	3	<1	<1	4.87E-03	1	3	<1	<1
Nickel	1.33E-01	1.7	14.8	<1	<1	8.72E-02	1.7	14.8	<1	<1
Selenium	1.36E-01	0.14	0.66	<1	<1	8.87E-02	0.14	0.66	<1	<1
Silver	3.22E-03	6.02	119	<1	<1	2.46E-03	6.02	119	<1	<1
Zinc	6.27E+01	75.4	298	<1	<1	4.33E+01	75.4	298	<1	<1

mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Created by:EC 1/20/14
QC'd by: SJP 2/8/14
Updated by: EC 3/1/15
QC'd by: RI 3/3/15

Appendix 1.a: Field pH measurements in surface water samples collected between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Measurement	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Animas River upstream of mainstem Cement Creek																									
A56 ("upstream)											7.61	7.44												7.39	6.64
A60											7.66	7.44													6.48
A61											7.38	7.36													7.37
A64											7.54	7.35													6.26
A65											7.47	7.24													7.01
A66											7.45	7.15													6.99
A68	6.74	6.82	6.85	7.18		7.15	7.51	6.98	7.28	7.37	7.39	7.09	7.61	7.18	7.21	6.52	6.92	7.52	7.26	7.42	7.2	7.39	6.87	7.42	7.71
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								5.54	
A70B																								6.05	
Animas River downstream of mainstem Mineral Creek																									
A71B																								6.10	
A72	5.07	5.04	6.09	5.3		7.08	7.09	6.51	6.5	6.59	6.87	6.33	6.88	6.40	6.46	5.93	6.41	6.48	6.25	7.08	6.51	6.38	6.23	5.98	7.00
A73											7.25	7.19												6.54	7.24
A73B											7.26	7.24												6.74	7.24
A75D											7.49	7.44												7.21	6.93
A75B											7.42	7.29												7.02	6.89
Bakers Bridge											7.64	7.63												7.20	7.58
Mainstem Cement Creek																									
CC48	3.5	3.42	3.93	3.54		5.40	4.29	5.34	5.24	4.43	4.43	4.6	3.95	3.51	3.65	3.50	3.57	3.45	3.51	4.54	3.45	3.51	3.24	3.40	4.00
CC49																								3.43	
Mainstem Mineral Creek																									
M34	4.97	5.02	6.22	5.12		6.49	7.30	7.00	7.19	7.07	7.23	6.83	7.19	6.73	6.70	5.62	6.77	6.73	6.4	7.28	6.82	6.68	5.90	6.15	7.05

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix 1.b: Hardness measurements in surface water samples collected between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFFPERIOD					RUNOFFPERIOD							POST-RUNOFF PERIOD												
Sampling Date	Feb 2010	Mar 2010	Apr 2010	Mar 2011	April 2014	May 2009	Jun 2009	Jun 2010	Jun 2011	May 2012	May 2013	May 2014	Jul 2009	Aug 2009	Sep 2009	Nov 2009	Jul 2010	Sep 2010	Nov 2010	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Oct 2012	Sept 2014
Measurement	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness	hardness
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Animas River upstream of mainstem Cement Creek																									
A56 ("upstream")					131						65	79												168	114
A60											74	78													111
A61											78	80													111
A64											63	76													113
A65											65	80													117
A66											64	79													120
A68	202	179	148	172	151	49	65	50	53	71	66	87	85	135	141	167	97	144	154	66	111	140	138	174	114
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								297	
A70B																								295	
Animas River downstream of mainstem Mineral Creek																									
A71B																								263	
A72	352	337	177	273		45	78	54	55	86	82	103	109	211	199	296	136	245	232	75	161	210	183	261	144
A73					182						71	88												251	142
A73B											37	54												217	83
A75D					133						60	76												191	92
A75B											61	70												193	85
Bakers Bridge					127						58	73												183	99
Mainstem Cement Creek																									
CC48	571	541	301	493		81	189	88	76	177	129	126	293	467	470	495	345	509	517	191	398	474	435	515	67
CC49																								545	
Mainestem Mineral Creek																									
M34	309	308	150	247		52	72	49	53	77	79	92	91	186	156	238	114	199	219	65	144	188	155	220	118

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix 1.c: Total and Dissolved Aluminum Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**	**Al-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					71.2						817	392												100 U	188
A60											370	452													174
A61											322	549													168
A64											343	514													150
A65											698	454													160
A66											653	547													174
A68	269	177	368	275	438	1010	165	348	540	154	534	508	117	120	134	189	100 U	124	101	217	100 U	100 U	100 U	100 U	164
Animas River between mainsteam Cement Creek and mainstem Mineral Creek																									
A69A																								2520 D	
A70B																								2460 D	
Animas River downstream of confluence with mainstem Mineral Creek																									
A71B																								2780 D	
A72	4440	4090	1980	3310		3060	679	585	1200	713	938	2340	812	2080	2080	2750	1090	2180	2540	597	1370	2070	1800	2620 D	1110
A73					1620						1280	1050												2420 D	933
A73B											666	640												1980 D	612
A75D					1260						1630	1060												1790 D	534
A75B											1650	1040												830 D	562
Bakers Bridge					843						1310	734												234 JD	399
Mainstem Cement Creek																									
CC48	8610	8100	5020	7540		1780	2920	1750	1610	2690	2690	3280	4120	7110	7050	7850	5270	7230	7930	2710	5830	6770	6810	7670 D	4890 D
CC49																								7800 D	
Mainstem Mineral Creek																									
M34	5950	5360	2160	4830		1130	773	665	2200	824	1270	2610	933	2630	2480	4590	1200	2960	3080	563	1600	2610	2170	3390 D	1260

Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**	**Al-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					40.8 J						48.7 J	58.1												42.7 J	61.4
A60											49.8 J	52.5													43.3 J
A61											70.4	116													64.9
A64											70.5	84.8													63
A65											81.4	89.9													54.7
A66											76.7	93.1													59.9
A68	141	100 U	100 U	100	82.9	100 U	100 U	100 U	100 U	57.2	93.3	112	100 U	100 U	100 U	103	100 U	25.0 U	25.0 U	100 U	100 U	100 U	100 U	62.2	73
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								603	
A70B																								1690	
Animas River downstream of confluence with mainstem Mineral Creek																									
A71B																								309	
A72	3290	2740	212	1570		100 U	100 U	100 U	100 U	33.6 J	58.9	37.4 J	100 U	131	171	959	100 U	25.0 U	193	100 U	100 U	117	103	342	38.9 J
A73					32.2 J						73.1	38.6 J												44.8 J	36.9 J
A73B											83.1	64.6												39.1 J	43.1 J
A75D					36.9 J						86.7	58.1												20 U	66.2
A75B											84.2	58.9												21.3 J	61.8
Bakers Bridge					69.1						84.2	79.3												26.2 J	76.9
Mainstem Cement Creek																									
CC48	8450	7820	4840	7660		751	2890	1050	798	2470	2290	2360	4050	7050	6930	7850	5270	7440	7720	2410	6030	7290	6770	7480 D	938
CC49																								7660 D	
Mainstem Mineral Creek																									
M34	4410	4700	160	3020		100 U	100 U	117	100 U	45.0 J	62.6	35.5 J	100 U	100 U	100 U	656	100 U	25.0 U	25.0 U	100 U	100 U	100 U	100 U	177 JD	46 J

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.d: Total and Dissolved Arsenic Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD						
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**
Metal-fraction	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek												
A56 ("upstream")					2.5 U						2.5 U	2.5 U
A60											2.5 U	2.5 U
A61											2.5 U	2.5 U
A64											2.5 U	2.5 U
A65											2.5 U	2.5 U
A66											2.5 U	2.5 U
A68	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U	2.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek												
A69A												
A70B												
Animas River downstream of the confluence with mainstem Mineral Creek												
A71B												
A72	4.0 U	4.0 U	4.0 U	4.0 U		5.0	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U	2.5 U
A73					2.5 U						2.5 U	2.5 U
A73B											2.5 U	2.5 U
A75D					2.5 U						2.5 U	2.5 U
A75B											2.5 U	2.5 U
Bakers Bridge					2.5 U						2.5 U	2.5 U
Mainstem Cement Creek												
CC48	7.7	6.6	4.0 U	5.0		4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	5.0 U	4.4 JD
CC49												
Mainstem Mineral Creek												
M34	4.0 U	4.0 U	4.0 U	4.0 U		4.0 U	4.0 U	4.0 U	4.5	2.5 U	2.5 U	3.2 JD

	POST-RUNOFF PERIOD												
Sampling Date	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**	**As-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek													
A56 ("upstream")												2.5 U	2.5 U
A60													2.5 U
A61													2.5 U
A64													U
A65													2.5 U
A66													2.5 U
A68	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek													
A69A												2.5 U	
A70B												2.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek													
A71B												2.5 U	
A72	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U
A73												2.5 U	2.5 U
A73B												2.5 U	2.5 U
A75D												2.5 U	2.5 U
A75B												2.5 U	2.5 U
Bakers Bridge												2.5 U	2.5 U
Mainstem Cement Creek													
CC48	4.0 U	4.0 U	4.0	5.4	4.0 U	1.0 U	4.3	4.0 U	4.0 U	4.0 U	4.0 U	4.8 JD	3.1 JD
CC49												4.7 JD	
Mainstem Mineral Creek													
M34	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U

	PRE-RUNOFF PERIOD					RUNOFF PERIOD						
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**
Metal-fraction	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek												
A56 ("upstream")					0.5 U						0.5 U	0.5 U
A60											0.5 U	0.5 U
A61											0.5 U	0.5 U
A64											0.5 U	0.5 U
A65											0.5 U	0.5 U
A66											0.5 U	0.5 U
A68	4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	0.5 U	0.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek												
A69A												
A70B												
Animas River downstream of the confluence with mainstem Mineral Creek												
A71B												
A72	4.0 U	4.0 U	4.0 U	4.0 U		4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	2.5 U	0.5 U
A73					0.5 U						2.5 U	0.5 U
A73B											0.5 U	0.5 U
A75D					0.5 U						0.5 U	0.5 U
A75B											0.5 U	0.5 U
Bakers Bridge					0.5 U						0.5 U	0.5 U
Mainstem Cement Creek												
CC48	4.0 U	4.0 U	4.0 U	4.0 U		4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	5.0 U	0.5 U
CC49												
Mainstem Mineral Creek												
M34	4.0 U	4.0 U	4.0 U	4.0 U		4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	2.5 U	0.5 U

	POST-RUNOFF PERIOD												
Sampling Date	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**	**As-diss**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek													
A56 ("upstream")												0.5 U	0.5 U
A60													0.5 U
A61													0.5 U
A64													0.5 U
A65													0.5 U
A66													0.5 U
A68	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	0.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek													
A69A												0.5 U	
A70B												0.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek													
A71B												0.5 U	
A72	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	0.5 U
A73												0.5 U	0.5 U
A73B												0.5 U	0.5 U
A75D												0.5 U	0.5 U
A75B												0.5 U	0.5 U
Bakers Bridge												0.5 U	0.5 U
Mainstem Cement Creek													
CC48	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U
CC49												2.5 U	
Mainstem Mineral Creek													
M34	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	0.5 U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix1.e: Totaland DissolvedBerylliumConcentrationsin Surface Water SamplesCollectedBetween 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date Metal-fraction Units	**Feb 2010 Be-total µg/L**	**Mar 2010 Be-total µg/L**	**Apr 2010 Be-total µg/L**	**Mar 2011 Be-total µg/L**	**April2014 Be-total µg/L**	**May 2009 Be-total µg/L**	**Jun 2009 Be-total µg/L**	**Jun 2010 Be-total µg/L**	**Jun 2011 Be-total µg/L**	**May 2012 Be-total µg/L**	**May 2013 Be-total µg/L**	**May 2014 Be-total µg/L**	**Jul 2009 Be-total µg/L**	**Aug 2009 Be-total µg/L**	**Sep 2009 Be-total µg/L**	**Nov 2009 Be-total µg/L**	**Jul 2010 Be-total µg/L**	**Sep 2010 Be-total µg/L**	**Nov 2010 Be-total µg/L**	**Jul 2011 Be-total µg/L**	**Aug 2011 Be-total µg/L**	**Sep 2011 Be-total µg/L**	**Oct 2011 Be-total µg/L**	**Oct 2012 Be-total µg/L**	**Sept 2014 Be-total µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.0 U						2.0 U	2.0 U												10.0 U	2.0 U
A60											2.0 U	2.0 U													2.0 U
A61											2.0 U	2.0 U													2.0 U
A64											2.0 U	2.0 U													2.0 U
A65											2.0 U	2.0 U													2.0 U
A66											2.0 U	2.0 U													U
A68	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	10.0 U	2.0 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								10.0 U	
A70B																								10.0 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B											2.0 U													10.0 U	
A72	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	10.0 U	2.0 U
A73					2.0 U						2.0 U	2.0 U												10.0 U	2.0 U
A73B											2.0 U	2.0 U												10.0 U	2.0 U
A75D					2.0 U						2.0 U	2.0 U												10.0 U	2.0 U
A75B											2.0 U	2.0 U												10.0 U	2.0 U
Bakers Bridge					2.0 U						2.0 U	2.0 U												10.0 U	2.0 U
Mainstem Cement Creek																									
CC48	1.3	1.3	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.2	1.2	1.2	1.0 U	1.3	1.4	1.0 U	1.0 U	1.0	1.0 U	10.0 U	10.0 U
CC49																								10.0 U	
Mainstem Mineral Creek																									
M34	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	10.0 U	2.0 U
Sampling Date Metal-fraction Units	**Feb 2010 Be-diss ug/L**	**Mar 2010 Be-diss µg/L**	**Apr 2010 Be-diss µg/L**	**Mar 2011 Be-diss µg/L**	**April2014 Be-diss µg/L**	**May 2009 Be-diss ug/L**	**Jun 2009 Be-diss µg/L**	**Jun 2010 Be-diss µg/L**	**Jun 2011 Be-diss µg/L**	**May 2012 Be-diss µg/L**	**May 2013 Be-diss µg/L**	**May 2014 Be-diss µg/L**	**Jul 2009 Be-diss µg/L**	**Aug 2009 Be-diss µg/L**	**Sep 2009 Be-diss µg/L**	**Nov 2009 Be-diss µg/L**	**Jul 2010 Be-diss µg/L**	**Sep 2010 Be-diss µg/L**	**Nov 2010 Be-diss µg/L**	**Jul 2011 Be-diss µg/L**	**Aug 2011 Be-diss µg/L**	**Sep 2011 Be-diss µg/L**	**Oct 2011 Be-diss µg/L**	**Oct 2012 Be-diss µg/L**	**Sept 2014 Be-diss µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.0 U						2.0 U	2.0 U												2.0 U	2.0 U
A60											2.0 U	2.0 U													2.0 U
A61											2.0 U	2.0 U													2.0 U
A64											2.0 U	2.0 U													2.0 U
A65											2.0 U	2.0 U													2.0 U
A66											2.0 U	2.0 U													2.0 U
A68	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2.0 U	
A70B																								2.0 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								2.0 U	
A72	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U
A73					2.0 U						2.0 U	2.0 U												2.0 U	2.0 U
A73B											2.0 U	2.0 U												2.0 U	2.0 U
A75D					2.0 U						2.0 U	2.0 U												2.0 U	2.0 U
A75B											2.0 U	2.0 U												2.0 U	2.0 U
Bakers Bridge					2.0 U						2.0 U	2.0 U												2.0 U	2.0 U
Mainstem Cement Creek																									
CC48	1.2	1.1	1.0 U	1.3		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.1	1.2	1.2	1.0 U	0.2 U	1.1	1.0 U	1.1	1.1	1.0 U	10.0 U	2.0 U
CC49																								10.0 U	
Mainstem Mineral Creek																									
M34	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	10.0 U	2.0 U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

Appendix 1.f: Total and Dissolved Cadmium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD						
Sampling Date	Feb 2010	Mar 2010	Apr 2010	Mar 2011	April2014	May 2009	Jun 2009	Jun 2010	Jun 2011	May 2012	May 2013	May 2014
Metal-fraction	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek												
A56 ("upstream")					0.596 JD						1.6 D	1.33 D
A60											1.3 D	1.17 D
A61											1.2 D	1.83 D
A64											1.3 D	1.49 D
A65											1.3 D	1.37 D
A66											1.4 D	1.5 D
A68	2.0	1.7	4.0	2.6	3.2 D	1.5	0.9	1.1	1.1	0.9 JD	1.5 D	1.52 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek												
A69A												
A70B												
Animas River downstream of the confluence with mainstem Mineral Creek												
A71B												
A72	2.5	2.8	2.9	2.7		1.2	0.8	0.9	0.9	0.9 JD	1.4 D	1.65 D
A73					2.18 D						1.0 JD	1.27 D
A73B											0.5 U	0.5 U
A75D					1.43 D						0.9 JD	0.924 JD
A75B											1.0 D	0.896 JD
Bakers Bridge					0.689 JD						0.7 JD	0.601 JD
Mainstem Cement Creek												
CC48	5.5	5.6	4.8	5.0		2.1	3.3	2.3	2.0	2.8 D	3.3 D	3.7 D
CC49												
Maintstem Mineral Creek												
M34	1.1	1.1	1.8	1.2		0.3	0.2	0.3	0.4	0.5 U	0.5 U	0.7 JD

	POST-RUNOFF PERIOD												
Sampling Date	Jul2009	Aug 2009	Sep 2009	Nov 2009	Jul2010	Sep 2010	Nov 2010	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Oct 2012	Sept2014
Metal-fraction	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total	Cd-total
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek													
A56 ("upstream")												1.0 D	0.99 JD
A60													0.93 JD
A61													0.99 JD
A64													0.93 JD
A65													0.94 JD
A66													1.0 D
A68	0.8	1.0	1.3	1.6	0.8	1.3	1.3	0.8	1.0	1.1	1.2	1.3 D	1.1 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek													
A69A												3.0 D	
A70B												2.7 D	
Animas River downstream of the confluence with mainstem Mineral Creek													
A71B												2.0 D	
A72	0.9	1.7	1.9	2.7	1.2	1.7	2.0	0.8	1.4	1.7	1.7	2.1 D	1.1 D
A73												2.2 D	0.97 JD
A73B												1.5 D	0.58 JD
A75D												1.3 D	0.51 JD
A75B												1.1 D	0.51 JD
Bakers Bridge												0.8 JD	0.50 U
Mainstem Cement Creek													
CC48	4.4	6.4	6.7	6.3	4.8	5.8	6.8	3.1	5.3	5.7	7.1	5.7 D	4.7 D
CC49												5.5 D	
Maintstem Mineral Creek													
M34	0.4	0.7	0.7	0.9	0.4	0.7	0.7	0.3	0.5	0.7	0.6	0.7 D	5.0 U

	PRE-RUNOFF PERIOD					RUNOFF PERIOD						
Sampling Date	Feb 2010	Mar 2010	Apr 2010	Mar 2011	April2014	May 2009	Jun 2009	Jun 2010	Jun 2011	May 2012	May 2013	May 2014
Metal-fraction	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss
Units	ug/L	µg/L	µg/L	µg/L	µg/L	ug/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek												
A56 ("upstream")					0.582						0.7	0.97
A60											0.7	1.01
A61											1.0	1.51
A64											0.9	1.35
A65											0.9	1.31
A66											0.9	1.4
A68	1.8	1.6	4.1	2.7	3.0	0.9	0.8	0.9	0.9	0.9	1.0	1.33
Animas River between mainstem Cement Creek and mainstem Mineral Creek												
A69A												
A70B												
Animas River downstream of the confluence with mainstem Mineral Creek												
A71B												
A72	2.6	2.7	2.9	2.6		0.6	0.8	0.7	0.8	0.9	1.0 D	1.4
A73					1.79						0.7 JD	1.09
A73B											0.3	0.564
A75D					1.02						0.5	0.711
A75B											0.5	0.694
Bakers Bridge					0.533						0.3	0.422
Mainstem Cement Creek												
CC48	5.5	5.3	4.9	5.3		2.1	3.4	2.2	2.0	2.9	3.2 D	3.8
CC49												
Mainstem Mineral Creek												
M34	1.1	1.0	2.0	1.1		0.3	0.2	0.2 U	0.2	0.3	0.5 U	0.6

	POST-RUNOFF PERIOD												
Sampling Date	Jul2009	Aug 2009	Sep 2009	Nov 2009	Jul2010	Sep 2010	Nov 2010	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Oct 2012	Sept2014
Metal-fraction	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss	Cd-diss
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek													
A56 ("upstream")												0.6	0.86
A60													0.99
A61													0.93
A64													1.0
A65													1.1
A66													1.1
A68	0.8	1.0	1.2	1.7	0.8	1.3	1.4	0.8	0.9	1.1	1.1	1.2	1.1
Animas River between mainstem Cement Creek and mainstem Mineral Creek													
A69A												2.7	
A70B												2.7	
Animas River downstream of the confluence with mainstem Mineral Creek													
A71B												1.9	
A72	0.9	1.8	1.8	2.8	1.1	1.8	2.1	0.7	1.3	1.7	1.6	1.8	1.2
A73												1.7	1.0
A73B												1.4	0.57
A75D												1.1	0.54
A75B												1.1	0.52
Bakers Bridge												0.7	0.35
Mainstem Cement Creek													
CC48	4.6	6.6	6.6	6.4	4.4	5.7	6.7	3.1	5.6	5.9	7.0	5.1 D	5.1 D
CC49												5.6 D	
Mainstem Mineral Creek													
M34	0.3	0.7	0.7	1.0	0.4	0.7	0.8	0.2	0.5	0.7	0.6	0.9 JD	0.39

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.g: Total and Dissolved Chromium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**	**Cr-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					5.0 U						5.0 U	5.0 U												5.0 U	5.0 U
A60											5.0 U	5.0 U													5.0 U
A61											5.0 U	5.0 U													5.0 U
A64											5.2 JD	5.0 U													5.0 U
A65											5.3 JD	5.0 U													5.0 U
A66											5.0 U	5.0 U													5.0 U
A68	2.0 U	2.0 U	2.0 U	5.0 U	5.0 U	2.0 U	2.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								5.0 U	
A70B																								5.0 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								5.0 U	
A72	2.0 U	2.0 U	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
A73					5.0 U						5.0 U	5.0 U												5.0 U	5.0 U
A73B											5.0 U	5.0 U												5.8 JD	5.0 U
A75D					5.0 U						5.0 U	5.0 U												5.0 U	5.0 U
A75B											5.0 U	5.0 U												5.0 U	5.0 U
Bakers Bridge					5.0 U						5.0 U	5.0 U												5.0 U	5.0 U
Mainstem Cement Creek																									
CC48	2.0 U	4.3	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	5.0 U	10.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
CC49																								13.6 D	
Mainstem Mineral Creek																									
M34	2.0 U	2.0 U	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**	**Cr-diss**
Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					1.0 U						1.0 U	1.0 U												1.0 U	1.0 U
A60											1.0 U	1.0 U													1.0 U
A61											1.0 U	1.0 U													1.0 U
A64											1.0 U	1.0 U													1.0 U
A65											1.0 U	1.0 U													1.0 U
A66											1.0 U	1.0 U													1.0 U
A68	2.0 U	2.0 U	2.0 U	5.0 U	1.0 U	2.0 U	2.0 U	5.0 U	5.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								1.0 U	
A70B																								1.0 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								1.0 U	
A72	2.0 U	2.0 U	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	1.0 U	5.0 U	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	2.3	1.0 U
A73					1.0 U						5.0 U	1.0 U												1.0 U	1.0 U
A73B											1.0 U	1.0 U												1.0 U	1.0 U
A75D					1.0 U						1.0 U	1.0 U												1.0 U	1.0 U
A75B											1.0 U	1.0 U												1.0 U	1.0 U
Bakers Bridge					1.0 U						1.0 U	1.0 U												1.0 U	1.0 U
Mainstem Cement Creek																									
CC48	2.0 U	2.0 U	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	1.0 U	10.0 U	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
CC49																								5.0 U	
Mainstem Mineral Creek																									
M34	2.0 U	2.0 U	2.0 U	5.0 U		2.0 U	2.0 U	5.0 U	5.0 U	1.0 U	5.0 U	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	5.0 U	0.5 U	0.5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.0 U

prepared by: SJP (1/20/14)
checked by: Emily(1/23/14)

updated by: Beth (2/9/15)
checked by: Emily(2/10/15)

Appendix 1.h: Total and Dissolved Copper Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**	**Cu-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					3.3 JD						46.0 D	25.9 D												2.5 U	3.9 JD
A60											33.1 D	27.1 D													4.1 JD
A61											21.7 D	33.5 D													5.0 D
A64											20.1 D	29.2 D													4.6 D
A65											25.7 D	29.9 D													5.0 JD
A66											24.9 D	30.3 D													5.1 D
A68	6.2	7.7	22.3	14.7	20.5 D	21.2	5.8	10.0 U	10.9	5.9 D	28.9 D	27.2 D	4.0	3.9	4.0	5.1	10.0 U	4.0 U	4.0 U	20.0 U	20.0 U	20.0 U	20.0 U	4.5 JD	4.7 JD
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								27.8 D	
A70B																								27.1 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								18.1 D	
A72	42.0	40.5	34.9	33.5		36.1	14.8	13.4	16.5	12.0 D	26.0 D	34.0 D	15.7	40.7	34.1	46.7	19.8	33.6	31.4	20.0 U	22.2	28.8	24.2	18.0 D	10.3 D
A73					19.3 D						22.8 D	22.5 D												15.9 D	8.3 D
A73B											8.5 D	11.8 D												13.1 D	4.3 JD
A75D					13.5 D						20.6 D	17.9 D												12.6 D	4.4 JD
A75B											21.5 D	17.9 D												5.2 D	4.1 JD
Bakers Bridge					7.9 D						16.3 D	11.0 D												2.5 U	2.8 JD
Mainstem Cement Creek																									
CC48	122	116	110	90.9		64.3	94.6	78.0	61.3	61.5 D	80.1 D	80.4 D	115	224	192	159	126	174	141	82.8	147	156	136	73.7 D	76.1 D
CC49																								66.9 D	
Mainstem Mineral Creek																									
M34	13.1	13.8	21.6	19.4		14.5	8.5	10.0 U	12.8	5.7 D	9.2 D	22.4 D	6.6	12.0	12.8	18.1	10.0 U	11.7	12.3	20.0 U	20.0 U	20.0 U	20.0 U	5.6 D	4.9 JD

Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**	**Cu-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.1						8.4	13.4												0.7 J	2.4
A60											7.8	12.6													2.8
A61											9.6	16.5													3.4
A64											8.5	14.3													3.5
A65											8.9	14.1													3.0
A66											9.1	13.9													3.5
A68	3.0 U	3.0 U	8.3	10.0 U	6.0	4.5	3.7	10.0 U	10.0 U	4.3	10.3	11.3	3.0 U	3.0 U	3.0 U	3.0 U	10.0 U	4.0 U	4.0 U	20.0 U	20.0 U	20.0 U	20.0 U	2.7	3.3
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								16.3	
A70B																								24.8	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								8.7	
A72	35.9	35.2	19.2	25.2		3.6	4.5	10.0 U	10.0 U	4.1	7.6 D	6.4	4.8	17.4	14.7	36.9	10.0 U	13.0	14.5	20.0 U	20.0 U	20.0 U	20.0 U	9.5	3.0
A73					2.5						5.0 D	4.9												4.3	1.9
A73B											2.0	3.8												3.1	1.4
A75D					2.1						3.7	4.2												0.6 J	1.9
A75B											3.7	4.1												0.7 J	2.0
Bakers Bridge					2.5						3.5	3.7												0.5 U	1.9
Mainstem Cement Creek																									
CC48	119	109	110	89.1		56.3	90.6	72.0	55.6	61.2	79.3 D	65.4	110	221	189	152	118	166	140	76.6	145	148	139	74.4 D	65.3 JD
CC49																								78.3 D	
Mainstem Mineral Creek																									
M34	10.3	11.2	12.3	16.2		3.9	3.0 U	10.0 U	10.0 U	1.7	2.5 U	3.1	3.0 U	3.4	3.7	9.5	10.0 U	4.0 U	4.0 U	20.0 U	20.0 U	20.0 U	20.0 U	3.8 JD	1.5

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.i: Total and Dissolved Iron Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**	**Fe-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					142 J						635	413												500 U	100 U
A60											257	408													100 U
A61											218 J	427													100 U
A64											130 J	497													100 U
A65											699	420													100 U
A66											669	675													111 J
A68	293	235	225	208	334	1100	100 U	376	544	111 J	437	536	100 U	115	151	234	100 U	129	169	189	116	158	169	500 U	100 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								5100 D	
A70B																								4890 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								4640 D	
A72	7710	7090	4190	5080		5300	948	986	1950	1270	2680	7200	1060	2990	3330	5490	1320	3230	4330	787	1750	2500	2740	4240 D	1340
A73					3850						4210	2580												3210 D	1080
A73B											1520	1400												2790 D	569
A75D					2730						4610	2530												2330 D	580
A75B											4810	2440												1060 JD	585
Bakers Bridge					1460						3560	1530												500 U	317
Mainstem Cement Creek																									
CC48	21700	19400	12700	14800		3950	4440	4160	3610	6510	17200	16600	6030	10800	13400	18600	5460	11500	14200	5230	7290	8630	11700	15100 D	8870 D
CC49																								14400 D	
Mainstem Mineral Creek																									
M34	6830	6380	4180	6080		2130	1060	1040	4200	1170	2720	6330	1340	3560	3500	8290	1780	4300	4870	754	2430	3340	3100	4630 D	1510
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**	**Fe-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					<100 U						100 U	100 U												100 U	100 U
A60											100 U	100 U													100 U
A61											100 U	100 U													100 U
A64											100 U	100 U													100 U
A65											100 U	100 U													100 U
A66											100 U	100 U													100 U
A68	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	10.0 U	10.0 U	100 U	100 U	100 U	100 U	100 U	100 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2180	
A70B																								2270	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								2480	
A72	3250	2500	1940	1800		100 U	343	224	199	746	628	913	463	1340	1500	3020	556	1610	2160	280	703	1050	1300	2210	443
A73					557						249 J	284												1020	115 J
A73B											120 J	157 J												810	104 J
A75D					100 U						144 J	100 U												100 U	100 U
A75B											137 J	100 U												100 U	100 U
Bakers Bridge					100 U						100 U	100 U												100 U	100 U
Mainstem Cement Creek																									
CC48	13300	9640	8610	10000		2000	3090	2300	2320	5360	4360	4590	3670	7750	9530	11600	4300	9010	11700	3600	5520	7110	8730	11300 D	1420
CC49																								11500 D	
Mainstem Mineral Creek																									
M34	2490	2470	1700	2390		139	374	173	100 U	512	554	545	764	2440	2050	4160	1190	3170	3900	337	1740	2400	2400	3510 D	858

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.j: Total and Dissolved Lead Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**	**Pb-total**
Units	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.4 D						81.3 D	14.1 D												2.3 D	1.9 D
A60											34.7 D	15.0 D													1.8 D
A61											23.1 D	12.8 D													2.0 D
A64											24.9 D	13.5 D													1.7 D
A65											50.5 D	14.3 D													2.8 D
A66											51.1 D	15.6 D													2.0 D
A68	2.7	2.4	4.4	5.4	3.9 D	52.3	2.5	15.3	19.6	2.8 D	43.3 D	14.7 D	2.1	1.4	2.0	1.9	1.5	2.2	1.7	4.9	1.7	1.7	1.7	2.9 D	2.01 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								6.2 D	
A70B																								5.8 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								4.5 D	
A72	8.9	6.6	14.7	9.2		99.8	3.3	12.3	24.8	4.3 D	29.2 D	24.3 D	4.0	4.5	5.8	6.2	5.8	5.6	7.0	6.0	4.8	5.6	5.6	4.8 D	3.42 D
A73					6.3 D						33.7 D	9.3 D												3.8 D	2.6 D
A73B											11.7 D	5.1 D												3.3 D	1.7 D
A75D					5.5 D						32.6 D	11.2 D												5.2 D	1.6 D
A75B											34.5 D	10.4 D												1.5 D	2.1 D
Bakers Bridge					5.4 D						26.0 D	5.7 D												0.6 JD	1.2 D
Mainstem Cement Creek																									
CC48	19.0	17.0	19.7	17.8		18.0	11.1	24.1	22.1	11.9 D	30.3 D	24.5 D	14.0	15.4	17.3	18.6	19.6	18.2	17.4	14.8	20.0	21.0	20.5	13.5 D	13.3 D
CC49																								13.0 D	
Mainstem Mineral Creek																									
M34	5.9	6.3	24.8	11.5		15.6	3.1	7.9	45.7	3.2 D	12.2 D	25.5 D	2.9	3.2	5.2	10.5	4.1	4.1	7.0	3.5	3.9	4.1	4.7	2.4 D	2.1 D
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**	**Pb-diss**
Units	**ug/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**ug/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 (reference)					0.4						0.6	1.0												0.2 J	0.216
A60											0.7	0.9													0.322
A61											0.7	1.0													0.342
A64											1.2	1.0													0.294
A65											1.3	0.9													0.280
A66											1.5	1.1													0.436
A68	1.0 U	1.0 U	1.0 U	1.0 U	0.1 U	1.0 U	1.0 U	1.0 U	1.0 U	0.6	1.3	1.1	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	0.1 J	0.381
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								0.2 J	
A70B																								3.0	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								0.1 U	
A72	2.7	1.3	1.0 U	1.5		1.0 U	1.0 U	1.0 U	1.0 U	0.1 U	1.2 D	0.1 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 J	0.1 U
A73					0.1 U						0.7 JD	0.2 J												0.1 U	0.1 U
A73B											0.3	0.1 J												0.1 U	0.1 U
A75D					0.1 U						0.8	0.3												0.1 U	0.1 U
A75B											0.8	0.3												0.1 U	0.1 J
Bakers Bridge					0.1 U						0.5	0.3												0.1 U	0.1 U
Mainstem Cement Creek																									
CC48	13.2	14.2	14.3	15.1		4.2	9.6	8.0	9.0	8.0	13.1 D	6.9	13.0	16.8	14.5	16.2	17.4	16.8	17.1	8.5	19.2	21.4	18.7	11.2 D	14.2 D
CC49																								11.3 D	
Mainstem Mineral Creek																									
M34	1.5	2.0	1.7	4.2		1.0 U	1.0 U	1.0 U	1.0 U	0.1 J	0.5 U	0.1 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	0.1 U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by: Emily (2/10/15)

Appendix 1.k: Total and Dissolved Manganese Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**	**Mn-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					187						567	287												189 D	482
A60											348	302													424
A61											477	917													481
A64											412	756													576
A65											578	771													630
A66											635	944													862
A68	3550	2830	3980	3200	3390	697	697	435	550	715	988	1300	676	1290	1580	2320	668	1280	1770	571	868	1120	1300	1350 D	835
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2640 D	
A70B																								2550 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								1670 D	
A72	2710	3110	1850	2440		755	492	311	397	488	734	898	596	1380	1430	2470	734	1450	1690	439	923	1290	1220	1580 D	884
A73					1860						609	689												1470 D	813
A73B											230	333												1210 D	395
A75D					1100						571	507												909 D	385
A75B											592	493												839 D	381
Bakers Bridge					638						468	327												561 D	272
Mainstem Cement Creek																									
CC48	5120	5490	3190	4950		809	1810	865	739	1660	1510	1770	2850	4900	5100	5530	3190	4780	5140	1790	3780	4490	4700	5070 D	3590 D
CC49																								5140 D	
Mainstem Mineral Creek																									
M34	615	559	328	567		219	130	112	313	123	151	242	174	401	374	596	209	440	429	115	275	394	302	428 D	226
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**41760**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**	**Mn-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					172						140	196												184	469
A60											153	189													416
A61											328	786													464
A64											240	639													569
A65											304	655													614
A66											343	805													860
A68	3560	2710	3730	3160	3340	340	636	335	415	699	656	1220	668	1320	1540	2380	649	1310	1790	537	821	1140	1310	1340	826
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2590	
A70B																								2540	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								1660	
A72	2710	2920	1770	2340		219	450	241	305	471	478	823	603	1420	1370	2490	736	1590	1690	405	923	1290	1180	1580	863
A73					1830						341	624												1440	811
A73B											109	294												1210	419
A75D					1090						232	408												847	371
A75B											233	394												856	363
Bakers Bridge					584						149	246												546	254
Mainstem Cement Creek																									
CC48	5290	5200	3040	4940		766	1770	811	731	1620	1440	1740	2830	4810	4920	5270	3280	5030	5220	1740	3890	4900	4620	5050 D	710
CC49																								5300 D	
Mainstem Mineral Creek																									
M34	630	634	324	530		160	120	84.9	150	115	128	184	169	410	336	592	212	435	456	104	293	406	303	435 D	221

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by Emily (2/10/15)

Appendix 1.I: Total and Dissolved Nickel Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total	Ni-total
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
A60											2.5 U	2.5 U													2.5 U
A61											2.5 U	2.5 U													2.5 U
A64											2.5 U	2.5 U													2.5 U
A65											2.5 U	2.5 U													2.5 U
A66											2.5 U	2.5 U													2.5 U
A68	2.0 U	2.0 U	2.0 U	4.0 U	2.5 U	2.0 U	2.0 U	4.0 U	4.0 U	2.5 U	2.5 U	2.5 U	2.0 U	2.0 U	2.0 U	2.0 U	4.0 U	0.7 U	0.7 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	2.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								4.6 JD	
A70B																								4.4 JD	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B											2.5 U													3.7 JD	
A72	7.0	7.0	2.0 U	5.2		2.0 U	2.0 U	4.0 U	4.0 U	2.5 U	2.5 U	2.5 U	2.0	3.9	3.3	6.3	4.0 U	0.7 U	5.4	4.0 U	4.0 U	4.0 U	4.0 U	4.6 JD	2.5 U
A73					2.5 U						2.5 U	2.5 U												3.8 JD	2.5 U
A73B											2.5 U	2.5 U												2.9 JD	2.5 U
A75D					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
A75B											2.5 U	2.5 U												2.5 U	2.5 U
Bakers Bridge					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
Mainstem Cement Creek																									
CC48	17.8	17.9	9.7	14.8		2.0	6.6	4.3	4.0 U	4.8 JD	5.0 U	3.5 JD	10	16.3	15.7	17.3	10	15.1	17.1	6.4	12.3	14	13.4	16.4 D	2.5 U
CC49																								22.7 D	
Mainstem Mineral Creek																									
M34	4.0	3.2	2.0 U	4.0 U		2.0 U	2.0 U	4.0 U	4.0 U	2.5 U	2.5 U	<2.5 U	2.0 U	2.3	2.0 U	3.7	4.0 U	0.7 U	0.7 U	4.0 U	4.0 U	4.0 U	4.0 U	2.6 JD	2.5 U

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss	Ni-diss
Units	ug/L	µg/L	µg/L	µg/L	µg/L	ug/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					0.5 U						0.5 U	0.5 U												0.5 U	0.5 U
A60											0.5 U	0.5 U													0.5 U
A61											0.5 U	0.5 U													0.5 U
A64											0.5 U	0.5 U													0.5 U
A65											0.5 U	0.5 U													0.5 U
A66											0.5 U	0.5 U													0.5 U
A68	2.0 U	2.0 U	2.0 U	4.0 U	0.5 U	2.0 U	2.0 U	4.0 U	4.0 U	0.5 U	0.5 U	0.5 U	2.0 U	2.0 U	2.0 U	2.0 U	4.0 U	0.7 U	0.7 U	4.0 U	4.0 U	4.0 U	4.0 U	0.5 U	0.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								4.8	
A70B																								5.2	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								4.9	
A72	8.2	6.4	3.4	5.8		2.0 U	2.0 U	4.0 U	4.0 U	0.9 J	2.5 U	0.606 J	2.0 U	3.0	3.7	6.4	4.0 U	0.7 U	4.2	4.0 U	4.0 U	4.0 U	4.0 U	5.9	1.1
A73					0.9 J						2.5 U	0.5 U												4.8	0.9 J
A73B											1.4	0.8 J												3.3	1.9
A75D					0.8 J						0.6 J	0.5 U												2.3	1.0 J
A75B											0.5 J	0.5 U												2.4	1.0
Bakers Bridge					0.5 U						0.5 U	0.5 U												0.6 J	0.7 J
Mainstem Cement Creek																									
CC48	19.4	16.3	10.3	16.4		2.2	5.3	4.0 U	4.0 U	4.9	5.0 U	3.1	9.1	15.0	15.7	17.4	8.6	16.5	16.2	6.0	13.0	14.5	13.7	12.4 D	5.9 D
CC49																								13.5 D	
Mainstem Mineral Creek																									
M34	5.3	3.3	2.0 U	4.0		2.0 U	2.0 U	4.0 U	4.0 U	0.6 J	2.5 U	0.5 U	2.0 U	2.1	2.3	4.1	4.0 U	0.7 U	0.7 U	4.0 U	4.0 U	4.0 U	4.0 U	2.5 U	0.5 J

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by Emily (2/10/15)

Appendix 1.m: Total and Dissolved Selenium Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**	**Se-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					5.0 U						2.5 U	5.0 U												2.5 U	5.0 U
A60											2.5 U	5.0 U													5.0 U
A61											2.5 U	5.0 U													5.0 U
A64											2.5 U	5.0 U													5.0 U
A65											2.5 U	5.0 U													5.0 U
A66											2.5 U	5.0 U													5.0 U
A68	1.0 U	1.6	1.0 U	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	2.5 U	5 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2.5 U	
A70B																								2.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								2.5 U	
A72	1.0 U	1.0	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	2.5 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	5 U
A73					5.0 U						2.5 U	5.0 U												2.5 U	5.0 U
A73B											2.5 U	5.0 U												2.5 U	5.0 U
A75D					5.0 U						2.5 U	5.0 U												2.5 U	5.0 U
A75B											2.5 U	5.0 U												2.5 U	5.0 U
Bakers Bridge					5.0 U						2.5 U	5.0 U												2.5 U	5.0 U
Mainstem Cement Creek																									
CC48	1.0 U	1.3	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	5.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	5.0 U
CC49																								2.5 U	
Mainstem Mineral Creek																									
M34	1.0 U	1.0	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	2.5 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	5.0 UJ
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**	**Se-diss**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					1.0 U						0.5 U	1.0 U												0.5 U	1.0 U
A60											0.5 U	1.0 U													1.0 U
A61											0.5 U	1.0 U													1.0 U
A64											0.5 U	1.0 U													1.0 U
A65											0.5 U	1.0 U													1.0 U
A66											0.5 U	1.0 U													1.0 U
A68	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	0.5 U	1 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	1 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								0.5 U	
A70B																								0.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								0.5 U	
A72	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	2.5 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	1.0 U
A73					1.0 U						2.5 U	1.0 U												0.5 U	1.0 U
A73B											0.5 U	1.0 U												0.5 U	1.0 U
A75D					1.0 U						0.5 U	1.0 U												0.5 U	1.0 U
A75B											0.5 U	1.0 U												0.5 U	1.0 U
Bakers Bridge					1.0 U						0.5 U	1.0 U												0.5 U	1.0 U
Mainstem Cement Creek																									
CC48	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	3.2 JD	5.0 U
CC49																								2.5 U	
Mainstem Mineral Creek																									
M34	1.0 U	1.0 U	1.0 U	1.0 U		1.0 U	1.0 U	1.0 U	1.0 U	0.5 U	2.5 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.2 U	0.2 U	1.0 U	1.0 U	1.0 U	1.0 U	2.5 U	1.0 U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by Beth (2/9/15)
checked by Emily (2/10/15)

Appendix 1.n: Total and Dissolved Silver Concentrations in Surface Water Samples Collected Between 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**	**Ag-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
A60											2.5 U	2.5 U													2.5 U
A61											2.5 U	2.5 U													2.5 U
A64											2.5 U	2.5 U													2.5 U
A65											2.5 U	2.5 U													2.5 U
A66											2.5 U	2.5 U													2.5 U
A68	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5	0.5 U	0.5 U	2.5 U	2.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								2.5 U	
A70B																								2.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B											2.5 U													2.5 U	
A72	0.5 U	0.5 U	0.5 U	0.5 U		0.5	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U
A73					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
A73B											2.5 U	2.5 U												2.5 U	2.5 U
A75D					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
A75B											2.5 U	2.5 U												2.5 U	2.5 U
Bakers Bridge					2.5 U						2.5 U	2.5 U												2.5 U	2.5 U
Mainstem Cement Creek																									
CC48	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	5.0 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U
CC49																								2.5 U	
Mainstem Mineral Creek																									
M34	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April 2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**	**Ag-diss**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					0.5 U						0.5 U	0.5 U												0.5 U	0.5 U
A60											0.5 U	0.5 U													0.5 U
A61											0.5 U	0.5 U													0.5 U
A64											0.5 U	0.5 U													0.5 U
A65											0.5 U	0.5 U													0.5 U
A66											0.5 U	0.5 U													0.5 U
A68	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								0.5 U	
A70B																								0.5 U	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								0.5 U	
A72	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
A73					0.5 U						2.5 U	0.5 U												0.5 U	0.5 U
A73B											0.5 U	0.5 U												0.5 U	0.5 U
A75D					0.5 U						0.5 U	0.5 U												0.5 U	0.5 U
A75B											0.5 U	0.5 U												0.5 U	0.5 U
Bakers Bridge					0.5 U						0.5 U	0.5 U												0.5 U	0.5 U
Mainstem Cement Creek																									
CC48	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.0 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U
CC49																								2.5 U	
Mainstem Mineral Creek																									
M34	0.6	0.5	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by Beth (2/9/15)
checked by Emily (2/10/15)

Appendix1.o: Total and DissolvedZinc Concentrationsin Surface Water SamplesCollectedBetween 2009 and 2014
Baseline Ecological Risk Assessment
Upper Animas Mining District

	PRE-RUNOFF PERIOD					RUNOFF PERIOD							POST-RUNOFF PERIOD												
Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**	**Zn-total**
Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					247						467	396												189 D	255
A60											384	426													267
A61											375	547													263
A64											358	504													259
A65											395	502													293
A66											400	516													340
A68	663	597	1180	874	1020	405	324	318	307	289	454	491	270	333	413	581	273	380	441	252	290	317	399	306 D	273
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								1170 D	
A70B																								1150 D	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								731 D	
A72	1060	1320	966	1080		306	303	221	237	293	453	489	310	659	650	1140	393	717	786	251	469	573	600	726 D	391
A73					768						352	426												685 D	372
A73B											119	204												557 D	181
A75D					483						288	306												545 D	181
A75B											283	296												445 D	183
Bakers Bridge					273						221	195												264 D	126
Mainstem Cement Creek																									
CC48	2570	2730	1840	2430		641	1130	655	551	1070	1180	1270	1600	2580	2690	2890	1720	2710	2620	1100	1970	2160	2510	2560 D	2030 D
CC49																								2590 D	
Mainstem Mineral Creek																									
M34	285	251	573	357		90	94.7	56.8	77.7	80.2	121	196	92	194	189	280	114	196	236	62.8	132	169	157	177 D	110

Sampling Date	**Feb 2010**	**Mar 2010**	**Apr 2010**	**Mar 2011**	**April2014**	**May 2009**	**Jun 2009**	**Jun 2010**	**Jun 2011**	**May 2012**	**May 2013**	**May 2014**	**Jul 2009**	**Aug 2009**	**Sep 2009**	**Nov 2009**	**Jul 2010**	**Sep 2010**	**Nov 2010**	**Jul 2011**	**Aug 2011**	**Sep 2011**	**Oct 2011**	**Oct 2012**	**Sept 2014**
Metal-fraction	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**	**Zn-diss**
Units	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**ug/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Animas River upstream of the confluence with mainstem Cement Creek																									
A56 ("upstream")					241						224	361												189	250
A60											242	360													266
A61											305	509													253
A64											280	452													260
A65											296	455													293
A66											292	461													341
A68	702	610	985	874	1030	295	270	286	274	281	347	446	268	332	407	567	261	410	436	237	282	311	393	300	270
Animas River between mainstem Cement Creek and mainstem Mineral Creek																									
A69A																								1160	
A70B																								1160	
Animas River downstream of the confluence with mainstem Mineral Creek																									
A71B																								743	
A72	1110	1230	864	972		133	249	206	217	284	369	453	313	636	617	1120	392	762	754	228	467	590	549	733	362
A73					701						242	364												682	327
A73B											79.0	178												561	180
A75D					367						140	217												427	152
A75B											140	210												442	149
Bakers Bridge					174						66.5	111												241	87.7
Mainstem Cement Creek																									
CC48	2670	2600	1600	2340		611	1080	660	614	1070	1160	1310	1620	2650	2570	2650	1800	2730	2890	1090	2140	2430	2400	2590 D	394
CC49																								2710 D	
Mainstem Mineral Creek																									
M34	328	292	499	312		48.1	72.5	68.6	50.0 U	68.2	100	146	88.7	180	175	317	106	196	242	54.4	131	170	142	173 D	98.8

prepared by: SJP (1/20/14)
checked by: Emily (1/23/14)

updated by: Beth (2/9/15)
checked by Emily (2/10/15)

Appendix 2.5
Total metals concentrations in sediment samples collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	9310 D	20.2 D	2.94 JD	11.6 D	3.6 D	244 D	21700 D	1180 D	9250 D	0.06 D	7.13 D	<1 U	3.62 D	3220 D
A60	mg/kg dw	7730 D	20.4 D	<2.03 U	9.55 D	3.88 D	262 D	23400 D	1610 D	7460 D	0.07 D	6.26 D	<1.02 U	5.96 D	2130 D
A61	mg/kg dw	9280 D	20.5 D	2.1 JD	4.95 D	3.55 D	286 D	22800 D	1400 D	8210 D	0.05 D	6.52 D	<0.995 U	5.23 D	2330 D
A64	mg/kg dw	9610 D	21.3 D	3.0 JD	7.93 D	3.55 D	264 D	24500 D	1120 D	6850 D	0.13 D	6.84 D	<1.01 U	4.88 D	2730 D
A65	mg/kg dw	8190 D	19.4 D	<1.99 U	6.82 D	3.76 D	271 D	25000 D	1220 D	8180 D	0.03 D	6.49 D	<0.997 U	3.61 D	1700 D
A66	mg/kg dw	9190 D	23.7 D	<2.03 U	9.17 D	3.7 D	243 D	25700 D	1190 D	8190 D	0.05 D	7.11 D	<1.01 U	4.81 D	2500 D
A68	mg/kg dw	7700 D	17.5 D	<1.97 U	10.8 D	3.73 D	216 D	24000 D	1240 D	9430 D	0.02 JD	6.56 D	<0.985 U	2.9 D	2480 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	9960 D	26.8 D	<2.03 U	3.03 D	3.01 D	133 D	42000 D	499 D	3400 D	0.05 D	5.33 D	<1.02 U	1.83 D	858 D
A73	mg/kg dw	6770 D	20.5 D	<2.04 U	2.7 D	3.5 D	113 D	36800 D	435 D	2780 D	0.02 JD	5.5 D	<1.02 U	1.24 D	749 D
A73B	mg/kg dw	6620 D	19.9 D	<2.03 U	2.72 D	3.68 D	98.8 D	35200 D	540 D	2480 D	0.04 D	8.16 D	<1.01 U	1.25 D	659 D
A75D	mg/kg dw	7660 D	17.5 D	<2.03 U	3.73 D	3.72 D	103 D	30800 D	339 D	3750 D	<0.02 U	8.2 BD	<1.02 U	0.948 JD	1080 D
A75B	mg/kg dw	6640 D	9.22 D	<1.99 U	1.99 D	5.01 D	67 D	20100 D	98 D	2070 D	<0.01 U	6.71 D	<0.994 U	0.512 JD	578 D
Bakers Bridge	mg/kg dw	8040 D	16.2 D	<1.99 U	4.63 D	4.74 D	92 D	27200 D	244 D	3970 D	0.02 JD	12.1 BD	<0.997 U	1.02 D	1700 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw	29100 D	32.7 D	<2.01 U	1.87 D	2.79 D	127 D	89000 D	237 D	1160 D	0.05 D	5.93 BD	<1.01 U	0.896 JD	666 D

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 2.1
Total metals concentrations in sediment samples collected in May 2012
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw														
A60	mg/kg dw														
A61	mg/kg dw														
A64	mg/kg dw														
A65	mg/kg dw														
A66	mg/kg dw														
A68	mg/kg dw	9050 D	25.9 D	<2.01 U	13.4 D	4.97 D	374 D	29100 D	1890 D	12200 D	0.081 D	8.95 D	1.29 D	7.09 D	3030 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	12200 D	40.6 D	<1.97 U	2.8 D	6.1 D	152 D	57500 D	581 D	2710 D	0.072 D	6.38 D	2.03 D	1.99 D	748 D
A73	mg/kg dw														
A73B	mg/kg dw														
A75D	mg/kg dw														
A75B	mg/kg dw														
Bakers Bridge	mg/kg dw														
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected
D = diluted sample
< = less than

Appendix 2.2
Total metals concentrations in sediment samples collected in October 2012
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver
Animas River above mainstem Cement Creek														
A56 ("upstream")	mg/kg dw	10300 D	31.9 D	<2.01 U	4.66 D	7.47 D	250 D	35600 D	1490 D	3140 D	0.17 D	7.61 D	1.64 D	7.15 D
A60	mg/kg dw													
A61	mg/kg dw													
A64	mg/kg dw													
A65	mg/kg dw													
A66	mg/kg dw													
A68	mg/kg dw	15300 D	89.5 D	6.77 D	24.2 D	5.69 D	745 D	45300 D	3030 D	22300 D	0.19 D	16.5 D	2.86 D	13.3 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek														
A69A	mg/kg dw													
A70B	mg/kg dw													
Animas River below of mainstem Mineral Creek														
A71B	mg/kg dw													
A72	mg/kg dw	21500 D	36.3 D	<2.00 U	1.81 D	4.05 D	179 D	56900 D	542 D	1470 D	0.06 D	4.79 D	1.83 D	2.76 D
A73	mg/kg dw	11800 D	25.5 D	<1.97 U	3.64 D	4.02 D	223 D	51600 D	729 D	4140 D	0.05 D	6.84 D	1.43 D	2.32 D
A73B	mg/kg dw	31900 D	39.4 D	3.24 JD	4.24 D	5.02 D	292 D	70700 D	468 D	2610 D	0.09 D	12.1 D	2.89 D	3.09 D
A75D	mg/kg dw	15600 D	13.2 D	<1.97 U	4.87 D	3.73 D	152 D	33700 D	231 D	3010 D	0.04 D	9.09 D	1.4 D	0.724 JD
A75B	mg/kg dw	48600 D	37.2 D	5.98 D	10.5 D	5.16 D	413 D	84500 D	435 D	3820 D	0.07 D	16.5 D	3.26 D	2.18 D
Bakers Bridge	mg/kg dw	37400 D	29.7 D	4.85 JD	18.6 D	5.21 D	357 D	68400 D	378 D	10500 D	0.06 D	31.6 D	3.1 D	1.71 D
mainstem Cement Creek														
CC48	mg/kg dw													
CC49	mg/kg dw	5310 D	40.6 D	<1.99 U	0.595 D	4.62 D	55.6 D	143000 D	282 D	478 D	0.06 D	2.85 D	0.747 JD	2.0 D
mainstem Mineral Creek														
M34	mg/kg dw	22400 D	21.1 D	<1.98 U	0.888 D	3.44 D	53.8 D	46500 D	129 D	1430 D	0.02 D	4.64 D	1.74 D	0.651 JD

Lab Qualifiers:
U = undetected
D = diluted sample
J = estimated value
B = blank contamination
< = less than

Appendix 2.3
Total metals concentrations in sediment samples collected in May 2013
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	8250 D	20.3 D	<1.97 U	12.8 D	4.65 BD	267 JD	26100 D	1820 BD	9760 D		5.99 D	0.548 JD	7.06 D	2330 D
A60	mg/kg dw	9160 D	24.4 D	<2.01 U	14.7 D	4.86 BD	286 D	24400 D	2100 BD	12600 D		7.58 D	<0.502 U	4.05 D	3180 D
A61	mg/kg dw	10600 D	44.0 D	2.53 JD	11.3 D	4.71 BD	466 D	27500 D	2120 BD	11000 D		7.19 D	<0.505 U	7.34 D	2840 D
A64	mg/kg dw	10500 D	44.2 D	2.77 JD	11.9 D	4.42 BD	336 D	30000 D	1770 BD	9670 D		7.2 D	0.905 JD	7.14 D	3470 D
A65	mg/kg dw	9250 D	30.3 D	<2.02 U	10.3 D	4.76 BD	328 D	28800 D	1840 BD	12900 D		6.68 D	<0.504 U	5.53 D	2590 D
A66	mg/kg dw	8370 D	26.9 D	<1.99 U	8.44 D	5.68 BD	257 D	29600 D	1750 BD	7830 D		5.92 D	<0.497 U	5.06 D	1950 D
A68	mg/kg dw	7650 D	26.3 D	<2.01 U	13.7 D	5.21 BD	352 D	28800 D	2180 BD	10300 D		8.76 D	<0.501 U	9.22 D	2830 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below of mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	11800 D	26.1 D	<1.97 U	1.15 D	6.41 BD	77.8 D	45800 D	299 BD	1210 D		4.88 D	1.04 D	1.3 D	386 D
A73	mg/kg dw	9220 D	31.9 D	<2.02 U	4.1 D	5.6 BD	176 D	55700 D	591 BD	3320 D		6.07 D	0.717 JD	2.78 D	998 D
A73B	mg/kg dw	10600 D	30.4 D	<2.00 U	3.56 D	4.72 BD	140 D	67100 D	593 BD	4340 D		9.78 D	<0.5 U	1.65 D	964 D
A75D	mg/kg dw	8550 D	18.2 D	<1.99 U	3.88 D	4.99 BD	108 D	34400 D	367 BD	3730 D		7.27 D	<0.498 U	1.37 D	1030 D
A75B	mg/kg dw	7220 D	13.3 D	<1.99 U	2.65 D	5.45 BD	82.7 D	26000 D	354 BD	2340 D		5.93 D	0.588 JD	1.51 D	672 D
Bakers Bridge	mg/kg dw	7360 D	15.9 D	<1.98 U	2.46 D	7.38 BD	116 D	28200 D	328 BD	2130 D		7.36 D	<0.496 U	1.08 D	2080 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 2.4
Total metals concentrations in sediment samples collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample location	Units	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	mg/kg dw	15100 D	33.1 D	6.35 D	17.8 D	4.72 D	432 D	40700 D	1220 D	12700 D	0.171 D	9.92 D	1.62 JD	7.64 D	6200 D
A60	mg/kg dw	13400 D	16.4 D	<2.01 U	5.84 D	6.35 D	166 D	33500 D	554 D	3400 D	0.033 D	9.62 D	<1.0 U	3.48 D	1530 D
A61	mg/kg dw	13500 D	19.8 D	2.99 JD	9.02 D	5.28 D	638 D	32000 D	891 D	6400 D	0.091 D	8.56 D	1.1 JD	4.28 D	2530 D
A64	mg/kg dw	10700 D	18.8 D	<2.02 U	6.25 D	5.15 D	199 D	31400 D	1050 D	4920 D	0.053 D	7.44 D	<1.01 U	3.59 D	1950 D
A65	mg/kg dw	13100 D	21.8 D	2.16 JD	10.2 D	5.49 D	331 D	31600 D	900 D	10300 D	0.073 D	9.9 D	<1.01 U	3.87 D	2890 D
A66	mg/kg dw	11700 D	18.3 D	2.24 JD	18.3 D	4.07 D	378 D	31700 D	1230 D	20500 D	0.06 D	10.1 D	<1.0 U	4.13 D	4380 D
A68	mg/kg dw	13000 D	19.1 D	2.82 JD	15.7 D	4.21 D	390 D	32400 D	1080 D	19700 D	0.056 D	10.3 D	<0.998 U	4.35 D	4890 D
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	mg/kg dw														
A70B	mg/kg dw														
Animas River below mainstem Mineral Creek															
A71B	mg/kg dw														
A72	mg/kg dw	18900 D	37 D	<2.0 U	1.7 D	3.45 D	145 D	74600 D	470 D	1710 D	0.039 D	4.33 D	1.05 JD	1.68 D	616 D
A73	mg/kg dw	40700 D	33.8 D	4.2 JD	5.6 D	2.83 D	284 D	109000 D	297 D	7120 D	0.036 D	7.19 D	<1.0 U	1.35 D	1450 D
A73B	mg/kg dw														
A75D	mg/kg dw	29900 D	28.5 D	3.66 JD	6.75 D	4.39 D	223 D	67900 D	261 D	6900 D	0.038 D	13.1 D	1.06 JD	1.27 D	2910 D
A75B	mg/kg dw														
Bakers Bridge	mg/kg dw	27300 D	25.9 D	3.51 JD	14.6 D	4.28 D	199 D	62100 D	248 D	13100 D	0.043 D	22 D	1.16 JD	1.33 D	6030 D
mainstem Cement Creek															
CC48	mg/kg dw														
CC49	mg/kg dw														
mainstem Mineral Creek															
M34	mg/kg dw														

Lab Qualifiers:
U = undetected B = blank contamination
D = diluted sample < = less than
J = estimated value

Appendix 3.1: Dissolved Metals Concentrations in Pore Water Samples Collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	µg/L	136	23.8 J	<0.500 U	<2.00 U	0.232	<1.00 U	1.3	<100 U	0.964	4.87 J	<0.500 U	<1.00 U	<0.500 U	124
A60	µg/L	158	20.9 J	0.547 J	<2.00 U	0.809	<1.00 U	1.41	<100 U	<0.100 U	<2.00 U	<0.500 U	<1.00 U	<0.500 U	353
A61	µg/L	853D	6170 D	<5.00 U	<20.0 U	100 D	<10.0 U	2250 D	<1000 U	13.4 D	78300 D	77.5 D	<10.0 U	<5.00 U	29900 D
A64	µg/L	141	<20.0 U	<0.500 U	<2.00 U	0.279	<1.00 U	1.83	<100 U	<0.100 U	4.27 J	<0.500 U	<1.00 U	<0.500 U	264
A65	µg/L	349.5	671	<0.500 U	<2.00 U	22.4	0.8 J	53.8	<100 U	2.00	18450	11.3	<1.00 U	<0.500 U	6230
A66	µg/L	141	<20.0 U	<0.500 U	<2.00 U	0.546	1.83 J	1.4	<100 U	0.123 J	226	<0.500 U	<1.00 U	<0.500 U	307
A68	µg/L	149	42.2 J	<0.500 U	<2.00 U	1.67	<1.00 U	3.46	<100 U	<0.100 U	1540	<0.500 U	<1.00 U	<0.500 U	675
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	µg/L														
A70B	µg/L														
Animas River below mainstem Mineral Creek															
A71B															
A72	µg/L	256	517	<0.500 U	<2.00 U	2.98	<1.00 U	8.07	<100 U	0.453	448	1.95	<1.00 U	<0.500 U	1630
A73	µg/L	185	29.2 J	<0.500 U	<2.00 U	2.03	<1.00 U	2.28	341	<0.100 U	1870	1.19	<1.00 U	<0.500 U	709
A73B	µg/L														
A75D	µg/L	135	27.7 J	<0.500 U	<2.00 U	0.387	<1.00 U	1.67	<100 U	<0.100 U	185	<0.500 U	<1.00 U	<0.500 U	173
A75B	µg/L														
Bakers Bridge	µg/L	125	47 J	<0.500 U	<2.00 U	0.334	1.15 J	2.21	<100 U	<0.100 U	325	<0.500 U	<1.00 U	<0.500 U	115
mainstem Cement Creek															
CC48	µg/L														
CC49	µg/L														
mainsem Mineral Creek															
M34	µg/L														

Appendix 3.2: Dissolved Metals Concentrations in Pore Water Samples Collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Zinc
Animas River above mainstem Cement Creek															
A56 ("upstream")	µg/L	129	28.4 J	<0.500 U	<2.00 U	1.16	<1.00 U	4.15	<100 U	0.523	689	<0.500 U	<1.00 U	<0.500 U	463
A60	µg/L	340	119	<2.50 U	<2.00 U	3.86 D	<5.00 U	2.67 JD	<100 U	<0.500 U	6.46	<2.50 U	<5.00 U	<2.50 U	1630
A61	µg/L	496.5	2604.5 D	<3.8 U	<11.0 U	106.5 D	<7.5 U	95.9 JD	<550 U	65.6 D	63800 D	37.8 D	<7.5 U	<3.8 U	18490 D
A64	µg/L														
A65	µg/L	389	401	<2.50 U	<2.00 U	22 D	<5.00 U	47.2 D	<100 U	0.579 JD	16200	13.4 D	<5.00 U	<2.50 U	4760
A66	µg/L	118	<20.0 U	<0.500 U	<2.00 U	0.296	<1.00 U	1.27	<100 U	<0.100 U	2.57 J	<0.500 U	<1.00 U	<0.500 U	179
A68	µg/L	121	42.8 J	<0.500 U	<2.00 U	1.06	<1.00 U	4.13	<100 U	0.258	590	<0.500 U	<1.00 U	<0.500 U	294
Animas River between mainstem Cement Creek and mainstem Mineral Creek															
A69A	µg/L														
A70B	µg/L														
Animas River below mainstem Mineral Creek															
71B	µg/L														
A72	µg/L	160	46.9 J	<0.500 U	<2.00 U	1.40	<1.00 U	2.87	338	<0.100 U	995	1.31	<1.00 U	<0.500 U	407
A73	µg/L	151	23.3 J	<0.500 U	<2.00 U	0.374	<1.00 U	1.18	<100 U	<0.100 U	2.45 J	1.35	<1.00 U	<0.500 U	362
A73B	µg/L	49	<20.0 U	<0.500 U	<2.00 U	<0.100 U	<1.00 U	0.915 J	<100 U	<0.100 U	3.37 J	0.581 J	<1.00 U	<0.500 U	32.9
A75D	µg/L	96	40 J	<0.500 U	<2.00 U	0.786	<1.00 U	2.60	107 J	0.205	290	1.52	<1.00 U	<0.500 U	190
A75B	µg/L														
Bakers Bridge	µg/L	271	35.2 J	3.74	<2.00 U	<0.100 U	3.23	<0.500 U	1260	0.193 J	5870	0.85 J	<1.00 U	<0.500 U	13.3 J
mainstem Cement Creek															
CC48	µg/L														
CC49	µg/L														
mainstem Mineral Creek															
M34	µg/L	139	45.7 J	<0.500 U	<2.00 U	0.127 J	<1.00 U	1.18	<100 U	<0.100 U	27.6	<0.500 U	<1.00 U	<0.500 U	48.2

prepared by: SJP (2/16/1

Appendix 4: Tissue residue data for benthic invertebrates collected from the Animas River in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sampling location	Analysis	Aluminum		Arsenic		Beryllium		Cadmium		Chromium		Copper		Iron		Lead		Manganese		Mercury		Nickel		Selenium		Silver		Zinc	
		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww		mg/kg ww	
A56	Total Recoverable Metals	91.8	D	0.141	JD	0.09	JD	0.347	D	0.44	D	5.79	D	57.9	D	2.63	D	31.2D	D	<0.025	U	0.0704	JD	0.256	D	<0.0614	U	99.8	D
A60	Total Recoverable Metals	120	D	0.13	JD	0.1	JD	0.545	D	0.703	D	19.5	D	73.4	D	5.25	D	25.6D	D	<0.049	U	<0.123	U	<0.246	U	<0.123	U	108	D
A68	Total Recoverable Metals	212	D	0.631	D	0.1	JD	1.16	D	0.834	D	18	D	986	D	7.57	D	60.5D	D	<0.053	U	0.155	JD	0.265	JD	<0.132	U	240	D
A72	Total Recoverable Metals	261	D	<0.16	U	<0.1	U	0.204	D	0.649	D	11.5	D	1190	D	2.27	D	17.3D	D	<0.064	U	<0.16	U	<0.321	U	<0.16	U	49.9	D
A73	Total Recoverable Metals	251	D	0.208	JD	<0.1	U	0.281	D	0.61	JD	9.98	D	847	D	2.02	D	32.6D	D	<0.066	U	0.173	JD	<0.33	U	<0.165	U	59.3	D
A75D	Total Recoverable Metals	78.4	D	<0.368	U	<0.3	U	0.235	D	0.978	JD	4.52	D	105	D	0.689	D	50.6D	D	<0.147	U	<0.368	U	<0.735	U	<0.368	U	56.2	D
Bakers Bridge	Total Recoverable Metals	114	D	<0.139	U	<0.1	U	0.478	D	0.615	D	5.28	D	156	D	0.761	D	76.6D	D	<0.056	U	0.477	D	<0.279	U	<0.139	U	106	D

Sampling location	Analysis	Aluminum		Arsenic		Beryllium		Cadmium		Chromium		Copper		Iron		Lead		Manganese		Mercury		Nickel		Selenium		Silver		Zinc	
		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw	
A56	Total Recoverable Metals	303	D	0.47	JD	0.30	JD	1.15	D	1.45	D	19.1	D	191	D	8.7	D	103	D	0.041	U	0.23	JD	0.84	D	0.10	U	329	D
A60	Total Recoverable Metals	396	D	0.43	JD	0.33	JD	1.80	D	2.32	D	64.4	D	242	D	17.3	D	84	D	0.081	U	0.20	U	0.41	U	0.20	U	356	D
A68	Total Recoverable Metals	700	D	2.08	D	0.33	JD	3.83	D	2.75	D	59.4	D	3254	D	25.0	D	200	D	0.087	U	0.51	JD	0.87	JD	0.22	U	792	D
A72	Total Recoverable Metals	861	D	0.26	U	0.17	U	0.67	D	2.14	D	38.0	D	3927	D	7.5	D	57	D	0.106	U	0.26	U	0.53	U	0.26	U	165	D
A73	Total Recoverable Metals	828	D	0.69	JD	0.17	U	0.93	D	2.01	JD	32.9	D	2795	D	6.7	D	108	D	0.109	U	0.57	JD	0.54	U	0.27	U	196	D
A75D	Total Recoverable Metals	259	D	0.61	U	0.50	U	0.78	D	3.23	JD	14.9	D	347	D	2.3	D	167	D	0.243	U	0.61	U	1.21	U	0.61	U	185	D
Bakers Bridge	Total Recoverable Metals	376	D	0.23	U	0.17	U	1.58	D	2.03	D	17.4	D	515	D	2.5	D	253	D	0.092	U	1.57	D	0.46	U	0.23	U	350	D

D = diluted; J = estimated value; U = not detected; dw = dry weight; ww = wet weight
notes:
all non-detected values were divided by half before calculating the dry weight concentrations
The moisture content of the benthic invertebrates was not measured and was assumed to equal 70% (= 30% dry matter); hence, the ww values were multiplied by a factor of 3.3 to convert them to dw values

Sampling location	Analysis	Aluminum		Arsenic		Beryllium		Cadmium		Chromium		Copper		Iron		Lead		Manganese		Mercury		Nickel		Selenium		Silver		Zinc	
		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw		mg/kg dw	
A56	Total Recoverable Metals	303	D	0.47	JD	0.30	JD	1.15	D	1.45	D	19.1	D	191	D	8.7	D	103	D	0.041	U	0.23	JD	0.84	D	0.10	U	329	D
A60	Total Recoverable Metals	396	D	0.43	JD	0.33	JD	1.80	D	2.32	D	64.4	D	242	D	17.3	D	84	D	0.081	U	0.20	U	0.41	U	0.20	U	356	D
A68	Total Recoverable Metals	700	D	2.08	D	0.33	JD	3.83	D	2.75	D	59.4	D	3254	D	25.0	D	200	D	0.087	U	0.51	JD	0.87	JD	0.22	U	792	D
A72	Total Recoverable Metals	861	D	0.26	U	0.17	U	0.67	D	2.14	D	38.0	D	3927	D	7.5	D	57	D	0.106	U	0.26	U	0.53	U	0.26	U	165	D
A73	Total Recoverable Metals	828	D	0.69	JD	0.17	U	0.93	D	2.01	JD	32.9	D	2795	D	6.7	D	108	D	0.109	U	0.57	JD	0.54	U	0.27	U	196	D
A75D	Total Recoverable Metals	259	D	0.61	U	0.50	U	0.78	D	3.23	JD	14.9	D	347	D	2.3	D	167	D	0.243	U	0.61	U	1.21	U	0.61	U	185	D
Bakers Bridge	Total Recoverable Metals	376	D	0.23	U	0.17	U	1.58	D	2.03	D	17.4	D	515	D	2.5	D	253	D	0.092	U	1.57	D	0.46	U	0.23	U	350	D

Appendix 7.1.a: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the pre-runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	2/10 Al-total µg/L	pH	hardness (mg/L)	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	5950	4.97	309	87	--	68	--
CC48	8610	3.50	571	87	--	99	--
A56 ("upstream")	NS						
A68	269	6.74	202	87	1279	3.1	0.2
A72	4440	5.07	352	87	--	51	--
A73	NS						
A75D	NS						
Bakers Bridge	NS						

Sampling Date / Metal-fraction / Units	3/10 Al-total µg/L	pH	hardness (mg/L)	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	5360	5.02	308	87	--	62	--
CC48	8100	3.42	541	87	--	93	--
A56 ("upstream")	NS						
A68	177	6.82	179	87	1084	2.0	0.2
A72	4090	5.04	337	87	--	47	--
A73	NS						
A75D	NS						
Bakers Bridge	NS						

Sampling Date / Metal-fraction / Units	4/10 Al-total µg/L	pH	hardness (mg/L)	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	2160	6.22	150	87	851	25	2.5
CC48	5020	3.93	301	87	--	58	--
A56 ("upstream")	NS						
A68	368	6.85	148	87	835	4.2	0.4
A72	1980	6.09	177	87	1067	23	1.9
A73	NS						
A75D	NS						
Bakers Bridge	NS						

Sampling Date / Metal-fraction / Units	3/11 Al-total µg/L	pH	hardness (mg/L)	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	4830	5.12	247	87	--	56	--
CC48	7540	3.54	493	87	--	87	--
A56 ("upstream")	NS						
A68	275	7.18	172	--	1026	--	0.3
A72	3310	5.30	273	87	--	38	--
A73	NS						
A75D	NS						
Bakers Bridge	NS						

NS = not sampled
criterion HQ = hazard quotient calculated using the chronic benchmark criterion; equation HQ = hazard quotient calculated using the chronic benchmark equati
shading shows HQ > 1.0 or highest HQ
[a] surface water pH was not measured in April 2014. To support the calculations, it was assumed that surface water pH fell below 7.0 based on pH values from previous years
the chronic surface water benchmarks for aluminum were calculated using the following equation: $e^{(1.3695*\ln hardness)-0.1158}$
The procedures for calculating the chronic HQs are as follows:
- use the chronic hardness-dependent equation if (a) pH $\geq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the more stringent of the chronic hardness-dependent equation or the 87 ug/L chronic total recoverable Al criterion if (a) pH $\leq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the 87 ug/L chronic total recoverable Al criterion if hardness > 220 mg/L

Appendix 7.1.b: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	5/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	6/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	6/10 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	1130	6.49	52	87	199	13	5.7	773	7.30	72	--	311	--	2.5	665	7.00	49	--	184	--	3.6
CC48	1780	5.40	81	87	366	20	4.9	2920	4.29	189	87	1168	34	2.5	1750	5.34	88	87	410	20	4.3
A56 ("upstream")	NS							NS							NS						
A60	NS							NS							NS						
A61	NS							NS							NS						
A64	NS							NS							NS						
A65	NS							NS							NS						
A66	NS							NS							NS						
A68	1010	7.15	49	--	184	--	5.5	165	7.51	65	--	271	--	0.6	348	6.98	50	87	189	4.0	1.8
A72	3060	7.08	45	--	164	--	19	679	7.09	78	--	347	--	2.0	585	6.51	54	87	210	6.7	2.8
A73	NS							NS							NS						
A73B	NS							NS							NS						
A75B	NS							NS							NS						
A75D	NS							NS							NS						
Bakers Bridge	NS							NS							NS						

Sampling Date / Metal-fraction / Units	6/11 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	5/12 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	2200	7.19	53	--	205	--	11	824	7.07	77	--	341	--	2.4
CC48	1610	5.24	76	87	335	19	4.8	2690	4.43	177	87	1067	31	2.5
A56 ("upstream")	NS							NS						
A60	NS							NS						
A61	NS							NS						
A64	NS							NS						
A65	NS							NS						
A66	NS							NS						
A68	540	7.28	53	--	205	--	2.6	154	7.37	71	--	305	--	0.5
A72	1200	6.50	55	87	215	14	5.6	713	6.59	86	87	397	8.2	1.8
A73	NS							NS						
A73B	NS							NS						
A75B	NS							NS						
A75D	NS							NS						
Bakers Bridge	NS							NS						

Sampling Date / Metal-fraction / Units	5/13 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	5/14 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	1270	7.23	79	--	354	--	3.6	2610	6.83	92	87	436	30	6.0
CC48	2690	4.43	129	87	692	31	3.9	3280	4.60	126	87	670	38	4.9
A56 ("upstream")	817	7.61	65	--	271	--	3.0	392	7.44	79	--	354	--	1.1
A60	370	7.66	74	--	323	--	1.1	452	7.44	78	--	347	--	1.3
A61	322	7.38	78	--	347	--	0.9	549	7.36	80	--	360	--	1.5
A64	343	7.54	63	--	259	--	1.3	514	7.35	76	--	335	--	1.5
A65	698	7.47	65	--	271	--	2.6	454	7.24	80	--	360	--	1.3
A66	653	7.45	64	--	265	--	2.5	547	7.15	79	--	354	--	1.5
A68	534	7.39	66	--	276	--	1.9	508	7.09	87	--	404	--	1.3
A72	938	6.87	82	87	372	11	2.5	2340	6.33	103	87	508	27	4.6
A73	1280	7.25	71	--	305	--	4.2	1050	7.19	88	--	410	--	2.6
A73B	666	7.26	37	--	125	--	5.3	640	7.24	54	--	210	--	3.0
A75B	1650	7.42	61	--	248	--	6.6	1040	7.29	70	--	300	--	3.5
A75D	1630	7.49	60	--	243	--	6.7	1060	7.44	76	--	335	--	3.2
Bakers Bridge	1310	7.64	58	--	232	--	5.7	734	7.63	73	--	317	--	2.3

criterion HQ = hazard quotient calculated using the chronic benchmark criterion; equation HQ = hazard quotient calculated using the chronic benchmark equation
shading shows HQ > 1.0 or highest HQ

the chronic surface water benchmarks for aluminum were calculated using the following equation: $e^{(1.3695*\ln \text{hardness})-0.1158}$
The procedures for calculating the chronic HQs are as follows:
- use the chronic hardness-dependent equation if (a) pH $\geq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the more stringent of the chronic hardness-dependent equation or the 87 ug/L chronic total recoverable Al criterion if (a) pH $\leq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the 87 ug/L chronic total recoverable Al criterion if hardness > 220 mg/L

Appendix 7.1.c: Calculating hardness-specific benchmarks and HQs for aluminum in surface water samples collected during the post-runoff period
Baseline Ecological Risk Assessment
Upper Animas River Mining District

POST-RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	7/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	8/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	9/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	933	7.19	91	--	429	--	2.2	2630	6.73	186	87	###	30	2.3	2480	6.70	156	87	898	29	2.8
CC48	4120	3.95	293	87	--	47	--	7110	3.51	467	87	--	82	--	7050	3.65	470	87	--	81	--
CC49	NS							NS							NS						
A56 (reference)	NS							NS							NS						
A60	NS							NS							NS						
A61	NS							NS							NS						
A64	NS							NS							NS						
A65	NS							NS							NS						
A66	NS							NS							NS						
A68	117	7.61	85	--	391	--	0.3	120	7.18	135	--	737	--	0.2	134	7.21	141	--	782	--	0.2
A69A	NS							NS							NS						
A70B	NS							NS							NS						
A71B	NS							NS							NS						
A72	812	6.88	109	87	549	9.3	1.5	2080	6.40	211	87	###	24	1.5	2080	6.46	199	87	###	24	1.7
A73	NS							NS							NS						
A73B	NS							NS							NS						
A75B	NS							NS							NS						
A75D	NS							NS							NS						
Bakers Bridge	NS							NS							NS						

Sampling Date / Metal-fraction / Units	11/09 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	7/10 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	9/10 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	4590	5.62	238	87	--	53	--	1200	6.77	114	87	584	14	2.1	2960	6.73	199	87	###	34	2.4
CC48	7850	3.50	495	87	--	90	--	5270	3.57	345	87	--	61	--	7230	3.45	509	87	--	83	--
CC49	NS							NS							NS						
A56 (reference)	NS							NS							NS						
A60	NS							NS							NS						
A61	NS							NS							NS						
A64	NS							NS							NS						
A65	NS							NS							NS						
A66	NS							NS							NS						
A68	189	6.52	167	87	986	2.2	0.2	50	6.92	97	87	468	0.6	0.1	124	7.52	144	--	805	--	0.2
A69A	NS							NS							NS						
A70B	NS							NS							NS						
A71B	NS							NS							NS						
A72	2750	5.93	296	87	--	32	--	1090	6.41	136	87	744	13	1.5	2180	6.48	245	87	--	25	--
A73	NS							NS							NS						
A73B	NS							NS							NS						
A75B	NS							NS							NS						
A75D	NS							NS							NS						
Bakers Bridge	NS							NS							NS						

POST-RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	11/10 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	7/11 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	8/11 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	9/11 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	3080	6.40	219	87	###	35	2.2	563	7.28	65	--	271	--	2.1	1600	6.82	144	87	805	18	2.0	2610	6.68	188	87	###	30	2.3
CC48	7930	3.51	517	87	--	91	--	2710	4.54	191	87	###	31	2.3	5830	3.45	398	87	--	67	--	6770	3.51	474	87	--	78	--
CC49	NS							NS							NS							NS						
A56 ("upstream")	NS							NS							NS							NS						
A60	NS							NS							NS							NS						
A61	NS							NS							NS							NS						
A64	NS							NS							NS							NS						
A65	NS							NS							NS							NS						
A66	NS							NS							NS							NS						
A68	101	7.26	154	--	882	--	0.1	217	7.42	66	--	276	--	0.8	50	7.20	111	--	563	--	0.1	50	7.39	140	--	774	--	0.1
A69A	NS							NS							NS							NS						
A70B	NS							NS							NS							NS						
A71B	NS							NS							NS							NS						
A72	2540	6.25	232	87	--	29	--	597	7.08	75	--	329	--	1.8	1370	6.51	161	87	937	16	1.5	2070	6.38	210	87	###	24	1.5
A73	NS							NS							NS							NS						
A73B	NS							NS							NS							NS						
A75B	NS							NS							NS							NS						
A75D	NS							NS							NS							NS						
Bakers Bridge	NS							NS							NS							NS						

Sampling Date / Metal-fraction / Units	10/11 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	10/12 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ	9/14 Al-total µg/L	pH	hardness	benchm. criterion	benchm. equation	criterion HQ	equation HQ
M34	2170	5.90	155	87	890	25	2.4	3390	6.15	220	87	###	39	2.4	1260	7.05	118	--	613	--	2.1
CC48	6810	3.24	435	87	--	78	--	7670	3.40	515	87	--	88	--	4890	4.00	67	87	282	56.2	17.3
CC49	NS							7800	3.43	545	87	--	90	--	NS						
A56 ("upstream")	NS							50	7.39	168	--	994	--	0.1	188	6.64	114	87	584	2.2	0.3
A60	NS							NS							174	6.48	111	87	563	2.0	0.3
A61	NS							NS							168	7.37	111	--	563	--	0.3
A64	NS							NS							150	6.26	113	87	577	1.7	0.3
A65	NS							NS							160	7.01	117	--	605	--	0.3
A66	NS							NS							174	6.99	120	87	627	2.0	0.3
A68	50	6.87	138	87	759	0.6	0.1	50	7.42	174	--	###	--	0.05	164	7.71	114	--	584	--	0.3
A69A	NS							2520	5.54	297	87	--	29	--	NS						
A70B	NS							2460	6.05	295	87	--	28	--	NS						
A71B	NS							2780	6.10	263	87	--	32	--	NS						
A72	1800	6.23	183	87	###	21	1.6	2620	5.98	261	87	--	30	--	1110	7.00	144	--	805	--	1.4
A73	NS							2420	6.54	251	87	--	28	--	933	7.24	142	--	789	--	1.2
A73B	NS							1980	6.74	217	87	###	23	1.4	612	7.24	83	--	378	--	1.6
A75B	NS							830	7.02	193	--	###	--	0.7	562	6.89	85	87	391	6.5	1.4
A75D	NS							1790	7.21	191	--	###	--	1.5	534	6.93	92	87	436	6.1	1.2
Bakers Bridge	NS							234	7.20	183	--	###	--	0.2	399	7.58	99	--	482	--	0.8

criterion HQ = hazard quotient calculated using the chronic benchmark criterion; equation HQ = hazard quotient calculated using the chronic benchmark equation
shading shows HQ > 1.0 or highest HQ
the chronic surface water benchmarks for aluminum were calculated using the following equation: $e^{(1.3695*\ln hardness)-0.1158}$
The procedures for calculating the chronic HQs are as follows:
- use the chronic hardness-dependent equation if (a) pH $\geq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the more stringent of the chronic hardness-dependent equation or the 87 ug/L chronic total recoverable Al criterion if (a) pH $\leq$ 7.0 and (b) hardness $\leq$ 220 mg/L
- use the 87 ug/L chronic total recoverable Al criterion if hardness > 220 mg/L

Appendix 7.2: Calculating hardness-specific benchmarks and HQs for dissolved cadmium in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.10	309	0.99	1.1	1.00	308	0.99	1.0	2.00	150	0.58	3.5	1.10	247	0.84	1.3				
CC48	5.50	571	1.57	3.5	5.30	541	1.51	3.5	4.90	301	0.97	5.0	5.30	493	1.41	3.8				
A56 ("upstream")																	0.58	131	0.52	1.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.80	202	0.72	2.5	1.60	179	0.66	2.4	4.10	148	0.57	7.2	2.70	172	0.64	4.2	3.00	151	0.58	5.2
A72	2.60	352	1.09	2.4	2.70	337	1.06	2.6	2.90	177	0.65	4.4	2.60	273	0.90	2.9				
A73																	1.79	182	0.67	2.7
A73B																				
A75D																	1.02	133	0.53	1.9
A75B																				
Bakers Bridge																	0.53	127	0.51	1.0

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.30	52	0.26	1.2	0.20	72	0.33	0.6	0.10	49	0.25	0.4	0.20	53	0.26	0.8	0.28	77	0.35	0.8	0.25	79	0.35	0.7	0.56	92	0.40	1.4
CC48	2.10	81	0.36	5.8	3.40	189	0.68	5.0	2.20	88	0.38	5.7	2.00	76	0.34	5.8	2.91	177	0.65	4.5	3.20	129	0.51	6.3	3.83	126	0.50	7.6
A56 ("upstream")																					0.70	65	0.31	2.3	0.97	79	0.35	2.7
A60																					0.70	74	0.34	2.1	1.01	78	0.35	2.9
A61																					1.00	78	0.35	2.9	1.51	80	0.36	4.2
A64																					0.90	63	0.30	3.0	1.35	76	0.34	3.9
A65																					0.90	65	0.31	2.9	1.31	80	0.36	3.7
A66																					0.90	64	0.30	3.0	1.40	79	0.35	4.0
A68	0.90	49	0.25	3.6	0.80	65	0.31	2.6	0.90	50	0.25	3.6	0.90	53	0.26	3.4	0.87	71	0.33	2.7	1.00	66	0.31	3.2	1.33	87	0.38	3.5
A72	0.60	45	0.23	2.6	0.80	78	0.35	2.3	0.70	54	0.27	2.6	0.80	55	0.27	3.0	0.89	86	0.38	2.4	1.00	82	0.36	2.7	1.40	103	0.43	3.2
A73																					0.70	71	0.33	2.1	1.09	88	0.38	2.8
A73B																					0.30	37	0.20	1.5	0.56	54	0.27	2.1
A75D																					0.50	60	0.29	1.7	0.71	76	0.34	2.1
A75B																					0.50	61	0.29	1.7	0.69	70	0.32	2.1
Bakers Bridge																					0.30	58	0.28	1.1	0.42	73	0.33	1.3

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10			
Metal-fraction	Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.30	91	0.39	0.8	0.70	186	0.67	1.0	0.70	156	0.59	1.2	1.00	238	0.81	1.2	0.40	114	0.47	0.9
CC48	4.60	293	0.95	4.9	6.60	467	1.34	4.9	6.60	470	1.35	4.9	6.40	495	1.40	4.6	4.40	345	1.07	4.1
CC49																				
A56 ("upstream")																				
A60																				
A61																				
A64																				
A65																				
A66																				
A68	0.80	85	0.37	2.1	1.00	135	0.53	1.9	1.20	141	0.55	2.2	1.70	167	0.62	2.7	0.80	97	0.41	1.9
A69A																				
A70B																				
A71B																				
A72	0.90	109	0.45	2.0	1.80	211	0.74	2.4	1.80	199	0.71	2.5	2.80	296	0.95	2.9	1.10	136	0.53	2.1
A73																				
A73B																				
A75D																				
A75B																				
Bakers Bridge																				

Sampling Date	9/10				11/10				7/11				8/11				9/11			
Metal-fraction	Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.70	199	0.71	1.0	0.80	219	0.76	1.1	0.20	65	0.31	0.7	0.50	144	0.56	0.9	0.70	188	0.68	1.0
CC48	5.70	509	1.43	4.0	6.70	517	1.45	4.6	3.10	191	0.69	4.5	5.60	398	1.19	4.7	5.90	474	1.36	4.3
CC49																				
A56 ("upstream")																				
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.30	144	0.56	2.3	1.40	154	0.58	2.4	0.80	66	0.31	2.6	0.90	111	0.46	2.0	1.10	140	0.54	2.0
A69A																				
A70B																				
A71B																				
A72	1.80	245	0.83	2.2	2.10	232	0.80	2.6	0.70	75	0.34	2.1	1.30	161	0.60	2.2	1.70	210	0.74	2.3
A73																				
A73B																				
A75D																				
A75B																				
Bakers Bridge																				

Sampling Date	10/11				10/12				9/14			
Metal-fraction	Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.		Cd-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.60	155	0.59	1.0	0.90	220	0.76	1.2	0.39	118	0.48	0.8
CC48	7.00	435	1.27	5.5	5.10	515	1.45	3.5	5.08	67	0.31	16.3
CC49					5.60	545	1.51	3.7				
A56 ("upstream")					0.60	168	0.62	1.0	0.86	114	0.47	1.9
A60									0.99	111	0.46	2.2
A61									0.93	111	0.46	2.0
A64									1.01	113	0.46	2.2
A65									1.05	117	0.48	2.2
A66									1.13	120	0.48	2.3
A68	1.10	138	0.54	2.0	1.20	174	0.64	1.9	1.08	114	0.47	2.3
A69A					2.70	297	0.96	2.8				
A70B					2.70	295	0.95	2.8				
A71B					1.90	263	0.87	2.2				
A72	1.60	183	0.67	2.4	1.80	261	0.87	2.1	1.19	144	0.56	2.1
A73					1.70	251	0.84	2.0	1.01	142	0.55	1.8
A73B					1.40	217	0.76	1.9	0.57	83	0.37	1.6
A75D					1.10	191	0.69	1.6	0.54	92	0.40	1.4
A75B					1.10	193	0.69	1.6	0.52	85	0.37	1.4
Bakers Bridge					0.70	183	0.67	1.1	0.35	99	0.42	0.8

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: $((1.101672-\ln hardness)*0.041838)*e^{(0.7988*\ln hardness)-4.4451}$

Appendix 7.3: Calculating hardness-specific benchmarks and HQs for dissolved chromium in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	2/10 Cr-diss ug/L	hardness	benchm.	HQ	3/10 Cr-diss µg/L	hardness	benchm.	HQ	4/10 Cr-diss µg/L	hardness	benchm.	HQ	3/11 Cr-diss µg/L	hardness	benchm.	HQ	4/14 Cr-diss µg/L	hardness	benchm.	HQ
M34	1.0	309	187	0.01	1.0	308	186	0.01	1.0	150	103	0.01	2.5	247	155	0.02				
CC48	1.0	571	309	0.00	1.0	541	295	0.00	1.0	301	183	0.01	2.5	493	274	0.01				
A56 ("upstream")																	0.5	131	92	0.01
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.0	202	132	0.01	1.0	179	119	0.01	1.0	148	102	0.01	2.5	172	116	0.02	0.5	151	104	<0.01
A72	1.0	352	208	0.00	1.0	337	200	0.00	1.0	177	118	0.01	2.5	273	169	0.01				
A73																	0.5	182	121	<0.01
A73B																				
A75D																	0.5	133	94	0.01
A75B																				
Bakers Bridge																	0.5	127	90	0.01

RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	5/09 Cr-diss ug/L	hardness	benchm.	HQ	6/09 Cr-diss µg/L	hardness	benchm.	HQ	6/10 Cr-diss µg/L	hardness	benchm.	HQ	6/11 Cr-diss µg/L	hardness	benchm.	HQ	5/12 Cr-diss µg/L	hardness	benchm.	HQ	5/13 Cr-diss µg/L	hardness	benchm.	HQ	5/14 Cr-diss µg/L	hardness	benchm.	HQ
M34	1.0	52	43	0.02	1.0	72	57	0.02	2.5	49	41	0.06	2.5	53	44	0.06	0.5	77	60	0.01	2.5	79	61	0.04	0.5	92	69	0.01
CC48	1.0	81	62	0.02	1.0	189	125	0.01	2.5	88	67	0.04	2.5	76	59	0.04	0.5	177	118	0.00	5.0	129	91	0.05	0.5	126	90	0.01
A56 ("upstream")																					0.5	65	52	0.01	0.5	79	61	0.01
A60																					0.5	74	58	0.01	0.5	78	60	0.01
A61																					0.5	78	60	0.01	0.5	80	62	0.01
A64																					0.5	63	51	0.01	0.5	76	59	0.01
A65																					0.5	65	52	0.01	0.5	80	62	0.01
A66																					0.5	64	51	0.01	0.5	79	61	0.01
A68	1.0	49	41	0.02	1.0	65	52	0.02	2.5	50	42	0.06	2.5	53	44	0.06	0.5	71	56	0.01	0.5	66	53	0.01	0.5	87	66	0.01
A72	1.0	45	39	0.03	1.0	78	60	0.02	2.5	54	45	0.06	2.5	55	45	0.06	0.5	86	66	0.01	2.5	82	63	0.04	0.5	103	76	0.01
A73																					2.5	71	56	0.04	0.5	88	67	0.01
A73B																					0.5	37	33	0.02	0.5	54	45	0.01
A75D																					0.5	60	49	0.01	0.5	76	59	0.01
A75B																					0.5	61	49	0.01	0.5	70	55	0.01
Bakers Bridge																					0.5	58	47	0.01	0.5	73	57	0.01

POST-RUNOFF PERIOD

Sampling Date / Metal-fraction / Units	7/09 Cr-diss ug/L	hardness	benchm.	HQ	8/09 Cr-diss µg/L	hardness	benchm.	HQ	9/09 Cr-diss µg/L	hardness	benchm.	HQ	11/09 Cr-diss µg/L	hardness	benchm.	HQ	7/10 Cr-diss µg/L	hardness	benchm.	HQ	9/10 Cr-diss µg/L	hardness	benchm.	HQ	11/10 Cr-diss µg/L	hardness	benchm.	HQ
M34	1.0	91	69	0.01	1.0	186	123	0.01	1.0	156	107	0.01	1.0	238	151	0.01	2.5	114	83	0.03	0.3	199	130	<0.01	0.3	219	141	<0.01
CC48	1.0	293	179	0.01	1.0	467	262	0.00	1.0	470	263	<0.01	1.0	495	275	0.00	2.5	345	204	0.01	0.3	509	281	<0.01	0.3	517	285	<0.01
CC49																												
A56 ("upstream")																												
A60																												
A61																												
A64																												
A65																												
A66																												
A68	1.0	85	65	0.02	1.0	135	95	0.01	1.0	141	98	0.01	1.0	167	113	0.01	2.5	97	72	0.03	0.3	144	100	<0.01	0.3	154	106	<0.01
A69A																												
A70B																												
A71B																												
A72	1.0	109	80	0.01	1.0	211	137	0.01	1.0	199	130	0.01	1.0	296	180	0.01	2.5	136	95	0.03	0.3	245	154	<0.01	0.3	232	148	<0.01
A73																												
A73B																												
A75D																												
A75B																												
Bakers Bridge																												

Sampling Date / Metal-fraction / Units	7/11 Cr-diss µg/L	hardness	benchm.	HQ	8/11 Cr-diss µg/L	hardness	benchm.	HQ	9/11 Cr-diss µg/L	hardness	benchm.	HQ	10/11 Cr-diss µg/L	hardness	benchm.	HQ	10/12 Cr-diss µg/L	hardness	benchm.	HQ	9/14 Cr-diss µg/L	hardness	benchm.	HQ
M34	2.5	65	52	0.05	2.5	144	100	0.03	2.5	188	124	0.02	2.5	155	106	0.02	2.5	220	141	0.02	0.5	118	85	0.01
CC48	2.5	191	126	0.02	2.5	398	230	0.01	2.5	474	265	0.01	2.5	435	247	0.01	2.5	515	284	0.01	2.5	67	53	0.05
CC49																	2.5	545	297	0.01				
A56 ("upstream")																	0.5	168	113	<0.01	0.5	114	83	0.01
A60																					0.5	111	81	0.01
A61																					0.5	111	81	0.01
A64																					0.5	113	82	0.01
A65																					0.5	117	84	0.01
A66																					0.5	120	86	0.01
A68	2.5	66	53	0.05	2.5	111	81	0.03	2.5	140	98	0.03	2.5	138	96	0.03	0.5	174	117	<0.01	0.5	114	83	0.01
A69A																	0.5	297	181	<0.01				
A70B																	0.5	295	180	<0.01				
A71B																	0.5	263	164	<0.01				
A72	2.5	75	59	0.04	2.5	161	109	0.02	2.5	210	136	0.02	2.5	183	122	0.02	2.3	261	163	0.01	0.5	144	100	0.01
A73																	0.5	251	157	<0.01	0.5	142	99	0.01
A73B																	0.5	217	140	<0.01	0.5	83	64	0.01
A75D																	0.5	191	126	<0.01	0.5	92	69	0.01
A75B																	0.5	193	127	<0.01	0.5	85	65	0.01
Bakers Bridge																	0.5	183	122	<0.01	0.5	99	74	0.01

the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln hardness)+0.534}$

Appendix 7.4: Calculating hardness-specific benchmarks and HQs for dissolved copper in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	10.3	309	23	0.4	11.2	308	23	0.5	12.3	150	13	1.0	16.2	247	19	0.8				
CC48	119	571	40	3.0	109	541	38	2.9	110	301	23	4.8	89.1	493	35	2.5				
A56 ("upstream")																	2.07	131	11	0.2
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.5	202	16	0.1	1.5	179	15	0.1	8.3	148	13	0.7	5.0	172	14	0.4	6.0	151	13	0.5
A72	35.9	352	26	1.4	35.2	337	25	1.4	19.2	177	15	1.3	25.2	273	21	1.2				
A73																	2.48	182	15	0.2
A73B																				
A75D																	2.14	133	11	0.2
A75B																				
Bakers Bridge																	2.49	127	11	0.2

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	3.9	52	5.1	0.8	1.5	72	6.8	0.2	5.0	49	4.9	1.0	5.0	53	5.2	1.0	1.7	77	7.2	0.2	1.3	79	7.3	0.2	3.1	92	8.3	0.4
CC48	56.3	81	7.5	7.5	90.6	189	15	5.9	72.0	88	8.0	9.0	55.6	76	7.1	7.8	61.2	177	15	4.2	79.3	129	11	7.1	65.4	126	11	6.0
A56 ("upstream")																					8.4	65.0	6.2	1.4	13.4	79	7.3	1.8
A60																					7.8	74.0	6.9	1.1	12.6	78	7.2	1.7
A61																					9.6	78.0	7.2	1.3	16.5	80	7.4	2.2
A64																					8.5	63.0	6.0	1.4	14.3	76	7.1	2.0
A65																					8.9	65.0	6.2	1.4	14.1	80	7.4	1.9
A66																					9.1	64.0	6.1	1.5	13.9	79	7.3	1.9
A68	4.5	49	4.9	0.9	3.7	65	6.2	0.6	5.0	50	5.0	1.0	5.0	53	5.2	1.0	4.3	71	6.7	0.6	10.3	66	6.3	1.6	11.3	87	8.0	1.4
A72	3.6	45	4.5	0.8	4.5	78	7.2	0.6	5.0	54	5.3	0.9	5.0	55	5.4	0.9	4.1	86	7.9	0.5	7.6	82	7.6	1.0	6.4	103	9.2	0.7
A73																					5.0	71.0	6.7	0.7	4.9	88	8.0	0.6
A73B																					2.0	37.0	3.8	0.5	3.8	54	5.3	0.7
A75D																					3.7	60.0	5.8	0.6	4.2	76	7.1	0.6
A75B																					3.7	61.0	5.9	0.6	4.1	70	6.6	0.6
Bakers Bridge																					3.5	58.0	5.6	0.6	3.7	73	6.8	0.5

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10			
Metal-fraction	Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.5	91	8.3	0.2	3.4	186	15	0.2	3.7	156	13	0.3	9.5	238	19	0.5	5.0	114	10	0.5	2.0	199	16	0.1	2.0	219	17	0.1
CC48	110	293	22	4.9	221	467	33	6.6	189	470	34	5.6	152	495	35	4.3	118	345	26	4.6	166	509	36	4.6	140	517	36	3.8
CC49																												
A56 ("upstream")																												
A60																												
A61																												
A64																												
A65																												
A66																												
A68	1.5	85	7.8	0.2	1.5	135	12	0.1	1.5	141	12	0.1	1.5	167	14	0.1	5.0	97	8.7	0.6	2.0	144	12	0.2	2.0	154	13	0.2
A69A																												
A70B																												
A71B																												
A72	4.8	109	9.6	0.5	17.4	211	17	1.0	14.7	199	16	0.9	36.9	296	23	1.6	5.0	136	12	0.4	13.0	245	19	0.7	14.5	232	18	0.8
A73																												
A73B																												
A75D																												
A75B																												
Bakers Bridge																												

Sampling Date	7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.		Cu-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	10.0	65	6.2	1.6	10.0	144	12	0.8	10.0	188	15	0.7	10.0	155	13	0.8	3.8	220	18	0.2	1.5	118	10	0.1
CC48	76.6	191	16	4.9	145	398	29	5.0	148	474	34	4.4	139	435	31	4.4	74.4	515	36	2.0	65.3	67	6.4	10.3
CC49																	78.3	545	38	2.1				
A56 ("upstream")																	0.7	168	14	0.1	2.4	114	10	0.2
A60																					2.8	111	9.8	0.3
A61																					3.4	111	9.8	0.4
A64																					3.5	113	9.9	0.3
A65																					3.0	117	10	0.3
A66																					3.5	120	10	0.3
A68	10.0	66	6.3	1.6	10.0	111	9.8	1.0	10.0	140	12	0.8	10.0	138	12	0.8	2.7	174	14	0.2	3.3	114	10	0.3
A69A																	16.3	297	23	0.7				
A70B																	24.8	295	23	1.1				
A71B																	8.7	263	20	0.4				
A72	10.0	75	7.0	1.4	10.0	161	13	0.7	10.0	210	17	0.6	10.0	183	15	0.7	9.5	261	20	0.5	3.0	144	12	0.2
A73																	4.3	251	20	0.2	1.9	142	12	0.2
A73B																	3.1	217	17	0.2	1.4	83	7.6	0.2
A75D																	0.6	191	16	0.0	1.9	92	8.3	0.2
A75B																	0.7	193	16	0.0	2.0	85	7.8	0.3
Bakers Bridge																	0.3	183	15	0.0	1.9	99	8.9	0.2

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln hardness)-1.7428}$

Appendix 7.5: Calculating hardness-specific benchmarks and HQs for dissolved manganese in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFFPERIOD

Sampling Date Metal-fraction Units	2/10 Mn-diss ug/L	hardness	benchm.	HQ	3/10 Mn-diss µg/L	hardness	benchm.	HQ	4/10 Mn-diss µg/L	hardness	benchm.	HQ	3/11 Mn-diss µg/L	hardness	benchm.	HQ	4/14 Mn-diss µg/L	hardness	benchm.	HQ
M34	630	309	2402	0.3	634	308	2399	0.3	324	150	1888	0.2	530	247	2229	0.2				
CC48	5290	571	2947	1.8	5200	541	2895	1.8	3040	301	2381	1.3	4940	493	2806	1.8				
A56 ("upstream")																	172	131	1805	0.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	3560	202	2085	1.7	2710	179	2003	1.4	3730	148	1880	2.0	3160	172	1976	1.6	3340	151	1892	1.8
A72	2710	352	2509	1.1	2920	337	2472	1.2	1770	177	1995	0.9	2340	273	2305	1.0				
A73																	1830	182	2014	0.9
A73B																				
A75D																	1090	133	1814	0.6
A75B																				
Bakers Bridge																	584	127	1786	0.3

RUNOFFPERIOD

Sampling Date Metal-fraction Units	5/09 Mn-diss ug/L	hardness	benchm.	HQ	6/09 Mn-diss µg/L	hardness	benchm.	HQ	6/10 Mn-diss µg/L	hardness	benchm.	HQ	6/11 Mn-diss µg/L	hardness	benchm.	HQ	5/12 Mn-diss µg/L	hardness	benchm.	HQ	5/13 Mn-diss µg/L	hardness	benchm.	HQ	5/14 Mn-diss µg/L	hardness	benchm.	HQ
M34	160	52	1327	0.1	120	72	1479	0.1	84.9	49	1301	0.1	150	53	1335	0.1	115	77	1512	0.1	128	79	1525	0.1	184	92	1604	0.1
CC48	766	81	1538	0.5	1770	189	2039	0.9	811	88	1581	0.5	731	76	1505	0.5	1620	177	1995	0.8	1440	129	1796	0.8	1740	126	1782	1.0
A56 ("upstream")																					140	65	1429	0.1	196	79	1525	0.1
A60																					153	74	1492	0.1	189	78	1519	0.1
A61																					328	78	1519	0.2	786	80	1531	0.5
A64																					240	63	1414	0.2	639	76	1505	0.4
A65																					304	65	1429	0.2	655	80	1531	0.4
A66																					343	64	1422	0.2	805	79	1525	0.5
A68	340	49	1301	0.3	636	65	1429	0.4	335	50	1309	0.3	415	53	1335	0.3	699	71	1472	0.5	656	66	1436	0.5	1220	87	1575	0.8
A72	219	45	1264	0.2	450	78	1519	0.3	241	54	1343	0.2	305	55	1352	0.2	471	86	1569	0.3	478	82	1544	0.3	823	103	1666	0.5
A73																					341	71	1472	0.2	624	88	1581	0.4
A73B																					109	37	1185	0.1	294	54	1343	0.2
A75D																					232	60	1391	0.2	408	76	1505	0.3
A75B																					233	61	1399	0.2	394	70	1465	0.3
Bakers Bridge																					149	58	1376	0.1	246	73	1485	0.2

POST-RUNOFF PERIOD

Sampling Date Metal-fraction Units	7/09 Mn-diss µg/L	hardness	benchm.	HQ	8/09 Mn-diss µg/L	hardness	benchm.	HQ	9/09 Mn-diss µg/L	hardness	benchm.	HQ	11/09 Mn-diss µg/L	hardness	benchm.	HQ	7/10 Mn-diss µg/L	hardness	benchm.	HQ	9/10 Mn-diss µg/L	hardness	benchm.	HQ
M34	169	91	1599	0.1	410	186	2028	0.2	336	156	1913	0.2	592	238	2202	0.3	212	114	1723	0.1	435	199	2075	0.2
CC48	2830	293	2360	1.2	4810	467	2756	1.7	4920	470	2762	1.8	5270	495	2810	1.9	3280	345	2492	1.3	5030	509	2837	1.8
CC49																								
A56 ("upstream")																								
A60																								
A61																								
A64																								
A65																								
A66																								
A68	668	85	1563	0.4	1320	135	1823	0.7	1540	141	1850	0.8	2380	167	1957	1.2	649	97	1633	0.4	1310	144	1863	0.7
A69A																								
A70B																								
A71B																								
A72	603	109	1698	0.4	1420	211	2115	0.7	1370	199	2075	0.7	2490	296	2368	1.1	736	136	1828	0.4	1590	245	2223	0.7
A73																								
A73B																								
A75D																								
A75B																								
Bakers Bridge																								

Sampling Date Metal-fraction Units	11/10 Mn-diss µg/L	hardness	benchm.	HQ	7/11 Mn-diss µg/L	hardness	benchm.	HQ	8/11 Mn-diss µg/L	hardness	benchm.	HQ	9/11 Mn-diss µg/L	hardness	benchm.	HQ	10/11 Mn-diss µg/L	hardness	benchm.	HQ	10/12 Mn-diss µg/L	hardness	benchm.	HQ	9/14 Mn-diss µg/L	hardness	benchm.	HQ
M34	456	219	2142	0.2	104	65	1429	0.1	293	144	1863	0.2	406	188	2036	0.2	303	155	1909	0.2	435	220	2145	0.2	221	118	1743	0.1
CC48	5220	517	2851	1.8	1740	191	2046	0.9	3890	398	2613	1.5	4900	474	2770	1.8	4620	435	2692	1.7	5050	515	2848	1.8	710	67	1444	0.5
CC49																					5300	545	2902	1.8				
A56 ("upstream")																					184	168	1961	0.1	469	114	1723	0.3
A60																									416	111	1708	0.2
A61																									464	111	1708	0.3
A64																									569	113	1718	0.3
A65																									614	117	1738	0.4
A66																									860	120	1753	0.5
A68	1790	154	1905	0.9	537	66	1436	0.4	821	111	1708	0.5	1140	140	1845	0.6	1310	138	1836	0.7	1340	174	1984	0.7	826	114	1723	0.5
A69A																					2590	297	2371	1.1				
A70B																					2540	295	2365	1.1				
A71B																					1660	263	2276	0.7				
A72	1690	232	2183	0.8	405	75	1499	0.3	923	161	1933	0.5	1290	210	2112	0.6	1180	183	2017	0.6	1580	261	2271	0.7	863	144	1863	0.5
A73																					1440	251	2241	0.6	811	142	1854	0.4
A73B																					1210	217	2135	0.6	419	83	1550	0.3
A75D																					847	191	2046	0.4	371	92	1604	0.2
A75B																					856	193	2054	0.4	363	85	1563	0.2
Bakers Bridge																					546	183	2017	0.3	254	99	1644	0.2

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331 * \ln \text{hardness}) + 5.8743}$

Appendix 7.6: Calculating hardness-specific benchmarks and HQs for dissolved nickel in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	5.3	309	135	0.04	3.3	308	135	0.02	1.0	150	73	0.01	4.0	247	112	0.04				
CC48	19.4	571	227	0.09	16.3	541	217	0.08	10.3	301	132	0.08	16.4	493	201	0.08				
A56 ("upstream")																	0.3	131	65	<0.01
A60																				
A61																				
A64																				
A65																				
A66																				
A68	1.0	202	94	0.01	1.0	179	85	0.01	1.0	148	72	0.01	2.0	172	82	0.02	0.3	151	74	<0.01
A72	8.2	352	151	0.05	6.4	337	145	0.04	3.4	177	84	0.04	5.8	273	122	0.05				
A73																	0.9	182	86	0.01
A73B																				
A75D																	0.8	133	66	0.01
A75B																				
Bakers Bridge																	0.3	127	64	0.00

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.0	52	30	0.03	1.0	72	39	0.03	2.0	49	28	0.07	2.0	53	30	0.07	0.6	77	42	0.02	1.3	79	43	0.03	0.3	92	48	0.01
CC48	2.2	81	44	0.05	5.3	189	89	0.06	2.0	88	47	0.04	2.0	76	41	0.05	4.9	177	84	0.06	2.5	129	65	0.04	3.1	126	63	0.05
A56 ("upstream")																					0.3	65	36	0.01	0.3	79	43	0.01
A60																					0.3	74	40	0.01	0.3	78	42	0.01
A61																					0.3	78	42	0.01	0.3	80	43	0.01
A64																					0.3	63	35	0.01	0.3	76	41	0.01
A65																					0.3	65	36	0.01	0.3	80	43	0.01
A66																					0.3	64	36	0.01	0.3	79	43	0.01
A68	1.0	49	28	0.04	1.0	65	36	0.03	2.0	50	29	0.07	2.0	53	30	0.07	0.3	71	39	0.01	0.3	66	37	0.01	0.3	87	46	0.01
A72	1.0	45	26	0.04	1.0	78	42	0.02	2.0	54	31	0.06	2.0	55	31	0.06	0.9	86	46	0.02	1.3	82	44	0.03	0.6	103	53	0.01
A73																					1.3	71	39	0.03	0.3	88	47	0.01
A73B																					1.4	37	22	0.06	0.8	54	31	0.03
A75D																					0.6	60	34	0.02	0.3	76	41	0.01
A75B																					0.5	61	34	0.01	0.3	70	38	0.01
Bakers Bridge																					0.3	58	33	0.01	0.3	73	40	0.01

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.0	91	48	0.02	2.1	186	88	0.02	2.3	156	76	0.03	4.1	238	108	0.04	2.0	114	58	0.03	0.4	199	93	0	0.4	219	101	0
CC48	9.1	293	129	0.07	15.0	467	192	0.08	15.7	470	193	0.08	17.4	495	201	0.09	8.6	345	148	0.06	16.5	509	206	0.08	16.2	517	209	0.08
CC49																												
A56 ("upstream")																												
A60																												
A61																												
A64																												
A65																												
A66																												
A68	1.0	85	45	0.02	1.0	135	67	0.01	1.0	141	70	0.01	1.0	167	80	0.01	2.0	97	51	0.04	0.4	144	71	0	0.4	154	75	0
A69A																												
A70B																												
A71B																												
A72	1.0	109	56	0.02	3.0	211	98	0.03	3.7	199	93	0.04	6.4	296	130	0.05	2.0	136	67	0.03	0.4	245	111	0	4.2	232	106	0.04
A73																												
A73B																												
A75D																												
A75B																												
Bakers Bridge																												

Sampling Date	7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.		Ni-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	2.0	65	36	0.06	2.0	144	71	0.03	2.0	188	89	0.02	2.00	155	75	0.03	1.3	220	101	0.01	0.5	118	60	0.01
CC48	6.0	191	90	0.07	13.0	398	167	0.08	14.5	474	194	0.07	13.70	435	180	0.08	12.4	515	208	0.06	5.9	67	37	0.16
CC49																	13.5	545	218	0.06				
A56 ("upstream")																	0.3	168	81	0.00	0.3	114	58	<0.01
A60																					0.3	111	57	<0.01
A61																					0.3	111	57	<0.01
A64																					0.3	113	58	<0.01
A65																					0.3	117	59	<0.01
A66																					0.3	120	61	<0.01
A68	2.0	66	37	0.05	2.0	111	57	0.04	2.0	140	69	0.03	2.00	138	68	0.03	0.3	174	83	0.00		114	58	<0.01
A69A																	4.8	297	131	0.04				
A70B																	5.2	295	130	0.04				
A71B																	4.9	263	118	0.04				
A72	2.0	75	41	0.05	2.0	161	78	0.03	2.0	210	97	0.02	2.00	183	87	0.02	5.9	261	117	0.05	1.1	144	71	0.02
A73																	4.8	251	113	0.04	0.9	142	70	0.01
A73B																	3.3	217	100	0.03	1.9	83	44	0.04
A75D																	2.3	191	90	0.03	1.0	92	48	0.02
A75B																	2.4	193	91	0.03	1.0	85	45	0.02
Bakers Bridge																	0.6	183	87	0.01	0.7	99	52	0.01

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln\text{ hardness})+0.0554}$

Appendix 7.7: Calculating hardness-specific benchmarks and HQs for dissolved lead in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	1.5	309	8.4	0.2	2.0	308	8.4	0.2	1.7	150	3.9	0.4	4.2	247	6.6	0.6				
CC48	13.2	571	15.7	0.8	14.2	541	14.9	1.0	14.3	301	8.2	1.8	15.1	493	13.5	1.1				
A56 ("upstream")																	0.381	131	3.4	0.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	0.5	202	5.4	0.1	0.5	179	4.7	0.1	0.5	148	3.8	0.1	0.5	172	4.5	0.1	0.05	151	3.9	0.01
A72	2.7	352	9.6	0.3	1.3	337	9.2	0.1	0.5	177	4.7	0.1	1.5	273	7.4	0.2				
A73																	0.05	182	4.8	0.01
A73B																				
A75D																	0.05	133	3.4	0.01
A75B																				
Bakers Bridge																	0.05	127	3.3	0.02

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.		Pb-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.5	52	1.2	0.4	0.5	72	1.8	0.3	0.5	49	1.1	0.4	0.5	53	1.3	0.4	0.1	77	1.9	0.1	0.3	79	1.9	0.1	0.1	92	2.3	0.05
CC48	4.2	81	2.0	2.1	9.6	189	5.0	1.9	8	88	2.2	3.7	9	76	1.9	4.8	8.0	177	4.7	1.7	13.1	129	3.3	3.9	6.9	126	3.2	2.1
A56 ("upstream")																					0.6	65	1.6	0.4	1.0	79	1.9	0.5
A60																					0.7	74	1.8	0.4	0.9	78	1.9	0.5
A61																					0.7	78	1.9	0.4	1.0	80	2.0	0.5
A64																					1.2	63	1.5	0.8	1.0	76	1.9	0.5
A65																					1.3	65	1.6	0.8	0.9	80	2.0	0.4
A66																					1.5	64	1.5	1.0	1.1	79	1.9	0.6
A68	0.5	49	1.1	0.4	0.5	65	1.6	0.3	0.5	50	1.2	0.4	0.5	53	1.3	0.4	0.6	71	1.7	0.4	1.3	66	1.6	0.8	1.1	87	2.2	0.5
A72	0.5	45	1.0	0.5	0.5	78	1.9	0.3	0.5	54	1.3	0.4	0.5	55	1.3	0.4	0.05	86	2.1	0.02	1.2	82	2.0	0.6	0.1	103	2.6	0.02
A73																					0.7	71	1.7	0.4	0.2	88	2.2	0.1
A73B																					0.3	37	0.8	0.4	0.1	54	1.3	0.1
A75D																					0.8	60	1.4	0.6	0.3	76	1.9	0.2
A75B																					0.8	61	1.5	0.5	0.3	70	1.7	0.2
Bakers Bridge																					0.5	58	1.4	0.4	0.3	73	1.8	0.2

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10				11/10			
Metal-fraction	Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.5	91	2.3	0.2	0.5	186	4.9	0.1	0.5	156	4.1	0.1	0.5	238	6.4	0.1	0.5	114	2.9	0.2	0.1	199	5.3	0.0	0.1	219	5.8	0.02
CC48	13	293	7.9	1.6	16.8	467	12.8	1.3	14.5	470	12.9	1.1	16.2	495	13.6	1.2	17.4	345	9.4	1.9	16.8	509	14.0	1.2	17.1	517	14.2	1.2
CC49																												
A56 ("upstream")																												
A60																												
A61																												
A64																												
A65																												
A66																												
A68	0.5	85	2.1	0.2	0.5	135	3.5	0.1	0.5	141	3.7	0.1	0.5	167	4.4	0.1	0.5	97	2.4	0.2	0.1	144	3.7	0.0	0.1	154	4.0	0.02
A69A																												
A70B																												
A71B																												
A72	0.5	109	2.8	0.2	0.5	211	5.6	0.1	0.5	199	5.3	0.1	0.5	296	8.0	0.1	0.5	136	3.5	0.1	0.1	245	6.6	0.0	0.1	232	6.2	0.02
A73																												
A73B																												
A75D																												
A75B																												
Bakers Bridge																												

Sampling Date	7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm		Pb-diss	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.5	65	1.6	0.3	0.5	144	3.7	0.1	0.5	188	5.0	0.1	0.5	155	4.0	0.1	0.3	220	5.9	0.04	0.1	118	3.0	0.02
CC48	8.5	191	5.1	1.7	19.2	398	10.9	1.8	21.4	474	13.0	1.6	18.7	435	11.9	1.6	11.2	515	14.2	0.8	14.2	67	1.6	8.7
CC49																	11.3	545	15.0	0.8				
A56 ("upstream")																	0.2	168	4.4	0.05	0.2	114	2.9	0.07
A60																					0.3	111	2.8	0.11
A61																					0.3	111	2.8	0.12
A64																					0.3	113	2.9	0.10
A65																					0.3	117	3.0	0.09
A66																					0.4	120	3.1	0.14
A68	0.5	66	1.6	0.3	0.5	111	2.8	0.2	0.5	140	3.6	0.1	0.5	138	3.6	0.1	0.1	174	4.6	0.02	0.4	114	2.9	0.13
A69A																	0.2	297	8.0	0.02				
A70B																	3.0	295	8.0	0.4				
A71B																	0.05	263	7.1	0.01				
A72	0.5	75	1.8	0.3	0.5	161	4.2	0.1	0.5	210	5.6	0.1	0.5	183	4.8	0.1	0.2	261	7.0	0.03	0.1	144	3.7	0.01
A73																	0.05	251	6.7	0.01	0.05	142	3.7	0.01
A73B																	0.05	217	5.8	0.01	0.05	83	2.1	0.02
A75D																	0.05	191	5.1	0.01	0.05	92	2.3	0.02
A75B																	0.05	193	5.1	0.01	0.14	85	2.1	0.07
Bakers Bridge																	0.05	183	4.8	0.01	0.05	99	2.5	0.02

Appendix 7.8: Calculating hardness-specific benchmarks and HQs for dissolved silver in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.		Ag-dissol	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.60	309	0.52	1.1	0.50	308	0.52	1.0	0.25	150	0.15	1.7	0.25	247	0.36	0.7				
CC48	0.25	571	1.50	0.2	0.25	541	1.37	0.2	0.25	301	0.50	0.5	0.25	493	1.17	0.2				
A56 ("upstream")																	0.25	131	0.12	2.1
A60																				
A61																				
A64																				
A65																				
A66																				
A68	0.25	202	0.25	1.0	0.25	179	0.20	1.2	0.25	148	0.15	1.7	0.25	172	0.19	1.3	0.25	151	0.15	1.6
A72	0.25	352	0.65	0.4	0.25	337	0.61	0.4	0.25	177	0.20	1.2	0.25	273	0.42	0.6				
A73																	0.25	182	0.21	1.2
A73B																				
A75D																	0.25	133	0.12	2.0
A75B																				
Bakers Bridge																	0.25	127	0.11	2.2

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.25	52	0.02	10.3	0.25	72	0.04	5.9	0.25	49	0.02	11.4	0.25	53	0.03	9.9	0.25	77	0.05	5.2	1.25	79	0.05	25.0	0.25	92	0.07	3.8
CC48	0.25	81	0.05	4.8	0.25	189	0.22	1.1	0.25	88	0.06	4.1	0.25	76	0.05	5.3	0.25	177	0.20	1.2	2.50	129	0.12	21.5	0.25	126	0.11	2.2
A56 ("upstream")																					0.25	65	0.04	7.0	0.25	79	0.05	5.0
A60																					0.25	74	0.04	5.6	0.25	78	0.05	5.1
A61																					0.25	78	0.05	5.1	0.25	80	0.05	4.9
A64																					0.25	63	0.03	7.4	0.25	76	0.05	5.3
A65																					0.25	65	0.04	7.0	0.25	80	0.05	4.9
A66																					0.25	64	0.03	7.2	0.25	79	0.05	5.0
A68	0.25	49	0.02	11.4	0.25	65	0.04	7.0	0.25	50	0.02	11.0	0.25	53	0.03	9.9	0.25	71	0.04	6.0	0.25	66	0.04	6.8	0.25	87	0.06	4.2
A72	0.25	45	0.02	13.1	0.25	78	0.05	5.1	0.25	54	0.03	9.6	0.25	55	0.03	9.3	0.25	86	0.06	4.3	1.25	82	0.05	23.4	0.25	103	0.08	3.2
A73																					1.25	71	0.04	30.0	0.25	88	0.06	4.1
A73B																					0.25	37	0.01	18.4	0.25	54	0.03	9.6
A75D																					0.25	60	0.03	8.0	0.25	76	0.05	5.3
A75B																					0.25	61	0.03	7.8	0.25	70	0.04	6.1
Bakers Bridge																					0.25	58	0.03	8.5	0.25	73	0.04	5.7

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				9/09				11/09				7/10				9/10			
Metal-fraction	Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.25	91	0.06	3.9	0.25	186	0.22	1.1	0.25	156	0.16	1.5	0.25	238	0.33	0.7	0.25	114	0.09	2.7	0.05	199	0.25	0.2
CC48	0.25	293	0.48	0.5	0.25	467	1.06	0.2	0.25	470	1.08	0.2	0.25	495	1.18	0.2	0.25	345	0.63	0.4	0.05	509	1.23	0.04
CC49																								
A56 ("upstream")																								
A60																								
A61																								
A64																								
A65																								
A66																								
A68	0.25	85	0.06	4.4	0.25	135	0.13	2.0	0.25	141	0.14	1.8	0.25	167	0.18	1.4	0.25	97	0.07	3.5	0.05	144	0.14	0.4
A69A																								
A70B																								
A71B																								
A72	0.25	109	0.09	2.9	0.25	211	0.27	0.9	0.25	199	0.25	1.0	0.25	296	0.49	0.5	0.25	136	0.13	2.0	0.05	245	0.35	0.1
A73																								
A73B																								
A75D																								
A75B																								
Bakers Bridge																								

Sampling Date	11/10				7/11				8/11				9/11				10/11				12/12				9/14			
Metal-fraction	Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm		Ag-dissol	hardness	benchm	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	0.05	219	0.29	0.2	0.25	65	0.04	7.0	0.25	144	0.14	1.8	0.25	188	0.22	1.1	0.25	155	0.16	1.6	1.25	220	0.29	4.3	0.25	118	0.10	2.5
CC48	0.05	517	1.27	0.0	0.25	191	0.23	1.1	0.25	398	0.81	0.3	0.25	474	1.09	0.2	0.25	435	0.94	0.3	1.25	515	1.26	1.0	1.25	67	0.04	33.2
CC49																					1.25	545	1.39	0.9				
A56 ("upstream")																					0.25	168	0.18	1.4	0.25	114	0.09	2.7
A60																									0.25	111	0.09	2.8
A61																									0.25	111	0.09	2.8
A64																									0.25	113	0.09	2.7
A65																									0.25	117	0.10	2.5
A66																									0.25	120	0.10	2.4
A68	0.05	154	0.16	0.3	0.25	66	0.04	6.8	0.25	111	0.09	2.8	0.25	140	0.13	1.9	0.25	138	0.13	1.9	0.25	174	0.19	1.3	0.25	114	0.09	2.7
A69A																					0.25	297	0.49	0.5				
A70B																					0.25	295	0.48	0.5				
A71B																					0.25	263	0.40	0.6				
A72	0.05	232	0.32	0.2	0.25	75	0.05	5.5	0.25	161	0.17	1.5	0.25	210	0.27	0.9	0.25	183	0.21	1.2	0.25	261	0.39	0.6	0.25	144	0.14	1.8
A73																					0.25	251	0.37	0.7	0.25	142	0.14	1.8
A73B																					0.25	217	0.28	0.9	0.25	83	0.05	4.6
A75D																					0.25	191	0.23	1.1	0.25	92	0.07	3.8
A75B																					0.25	193	0.23	1.1	0.25	85	0.06	4.4
Bakers Bridge																					0.25	183	0.21	1.2	0.25	99	0.07	3.4

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln hardness)-10.51}$

Appendix 7.9: Calculating hardness-specific benchmarks and HQs for dissolved zinc in surface water samples
Baseline Ecological Risk Assessment
Upper Animas River Mining District

PRE-RUNOFF PERIOD

Sampling Date	2/10				3/10				4/10				3/11				4/14			
Metal-fraction	Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	328	309	338	1.0	292	308	337	0.9	499	150	175	2.8	312	247	276	1.1				
CC48	2670	571	591	4.5	2600	541	563	4.6	1600	301	330	4.8	2340	493	517	4.5				
A56 ("upstream")																	241	131	155	1.6
A60																				
A61																				
A64																				
A65																				
A66																				
A68	702	202	230	3.1	610	179	206	3.0	985	148	173	5.7	874	172	198	4.4	1030	151	176	5.8
A72	1110	352	381	2.9	1230	337	366	3.4	864	177	204	4.2	972	273	302	3.2				
A73																	701	182	209	3.4
A73B																				
A75D																	367	133	157	2.3
A75B																				
Bakers Bridge																	174	127	151	1.2

RUNOFF PERIOD

Sampling Date	5/09				6/09				6/10				6/11				5/12				5/13				5/14			
Metal-fraction	Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.	
Units	ug/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	48.1	52	67	0.7	72.5	72	90	0.8	68.6	49	63	1.1	25.0	53	68	0.4	68.2	77	96	0.7	100	79	98	1.0	146	92	112	1.3
CC48	611	81	100	6.1	1080	189	216	5.0	660	88	108	6.1	614	76	94	6.5	1070	177	204	5.3	1160	129	153	7.6	1310	126	150	8.8
A56 ("upstream")																					224	65.0	82	2.7	361	79.0	98	3.7
A60																					242	74.0	92	2.6	360	78.0	97	3.7
A61																					305	78.0	97	3.2	509	80.0	99	5.1
A64																					280	63.0	80	3.5	452	76.0	94	4.8
A65																					296	65.0	82	3.6	455	80.0	99	4.6
A66																					292	64.0	81	3.6	461	79.0	98	4.7
A68	295	49	63	4.7	270	65	82	3.3	286	50	65	4.4	274	53	68	4.0	281	71	89	3.2	347	66	83	4.2	446	87	107	4.2
A72	133	45	59	2.3	249	78	97	2.6	206	54	69	3.0	217	55	70	3.1	284	86	106	2.7	369	82	101	3.6	453	103	124	3.6
A73																					242	71.0	89	2.7	364	88.0	108	3.4
A73B																					79.0	37.0	49	1.6	178	54.0	69	2.6
A75D																					140	60.0	76	1.8	217	76.0	94	2.3
A75B																					140	61.0	77	1.8	210	70.0	88	2.4
Bakers Bridge																					66.5	58.0	74	0.9	111	73.0	91	1.2

POST-RUNOFF PERIOD

Sampling Date	7/09				8/09				10/09				11/09				7/10				9/10				11/10			
Metal-fraction	Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	88.7	91	111	0.8	180	186	213	0.8	175	156	182	1.0	317	238	267	1.2	106	114	137	0.8	196	199	227	0.9	242	219	247	1.0
CC48	1620	293	322	5.0	2650	467	492	5.4	2570	470	495	5.2	2650	495	519	5.1	1800	345	374	4.8	2730	509	532	5.1	2890	517	540	5.4
CC49																												
A56 ("upstream")																												
A60																												
A61																												
A64																												
A65																												
A66																												
A68	268	85	105	2.6	332	135	159	2.1	407	141	166	2.5	567	167	193	2.9	261	97	118	2.2	410	144	169	2.4	436	154	179	2.4
A69A																												
A70B																												
A71B																												
A72	313	109	131	2.4	636	211	239	2.7	617	199	227	2.7	1120	296	325	3.4	392	136	160	2.4	762	245	274	2.8	754	232	261	2.9
A73																												
A73B																												
A75D																												
A75B																												
Bakers Bridge																												

Sampling Date	7/11				8/11				9/11				10/11				10/12				9/14			
Metal-fraction	Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.		Zn-diss	hardness	benchm.	
Units	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ	µg/L			HQ
M34	54.4	65	82	0.7	131	144	169	0.8	170	188	215	0.8	142	155	181	0.8	173	220	248	0.7	99	118	141	0.7
CC48	1090	191	218	5.0	2140	398	426	5.0	2430	474	499	4.9	2400	435	461	5.2	2590	515	538	4.8	394	67	84	4.7
CC49																	2710	545	566	4.8				
A56 ("upstream")																	189	168	194	1.0	250	114	137	1.8
A60																					266	111	133	2.0
A61																					253	111	133	1.9
A64																					260	113	135	1.9
A65																					293	117	140	2.1
A66																					341	120	143	2.4
A68	237	66	83	2.9	282	111	133	2.1	311	140	165	1.9	393	138	162	2.4	300	174	201	1.5	270	114	137	2.0
A69A																	1160	297	326	3.6				
A70B																	1160	295	324	3.6				
A71B																	743	263	292	2.5				
A72	228	75	93	2.4	467	161	187	2.5	590	210	238	2.5	549	183	210	2.6	733	261	290	2.5	362	144	169	2.1
A73																	682	251	280	2.4	327	142	167	2.0
A73B																	561	217	245	2.3	180	83	102	1.8
A75D																	427	191	218	2.0	152	92	112	1.4
A75B																	442	193	220	2.0	149	85	105	1.4
Bakers Bridge																	241	183	210	1.1	87.7	99	120	0.7

shading shows HQs > 1.0

the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $e^{((0.8525*\ln hardness)+0.9109)*0.986}$

Appendix 8.2: Calculating sample-specific HQs for dissolved metals in pore water samples collected in September 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum				Arsenic				Beryllium				Cadmium				Chromium				Copper				Iron			
Animas River above mainstem Cement Creek					BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ			BM	HQ
A56 ("upstream")	µg/L	129	28.4 J	28.4	87	0.33	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.16	1.16	0.51	2.3	<1.00 U	0.5	91	0.01	4.15	4.15	11	0.4	<100 U	50	1000	0.1
A60	µg/L	340	119	119	87	1.37	<2.50 U	0.12	150	0.00	<2.00 U	1.0	0.66	1.5	3.86 D	3.86	1.07	3.6	<5.00 U	2.5	202	0.01	2.67 JD	2.67	25	0.1	<100 U	50	1000	0.1
A61	µg/L	497	2604.5 D	2604.5	87	29.9	<3.8 U	1.7	150	0.01	<11.0 U	5.5	0.66	8.3	106.5 D	106.5	1.42	75.2	<7.5 U	3.75	275	0.01	95.9 JD	95.9	35	2.7	<550 U	275	1000	0.3
A64	µg/L																													
A65	µg/L	389	401	401	87	4.61	<2.50 U	1.25	150	0.01	<2.00 U	1.0	0.66	1.5	22 D	22	1.18	18.7	<5.00 U	2.5	225	0.01	47.2 D	47.2	29	1.7	<100 U	50	1000	0.1
A66	µg/L	118	<20.0 U	10	87	0.11	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.296	0.296	0.48	0.6	<1.00 U	0.5	85	0.01	1.27	1.27	10	0.1	<100 U	50	1000	0.1
A68	µg/L	121	42.8 J	42.8	87	0.49	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.06	1.06	0.49	2.2	<1.00 U	0.5	87	0.01	4.13	4.13	11	0.4	<100 U	50	1000	0.1
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																														
A69A	µg/L																													
A70B	µg/L																													
Animas River below mainstem Mineral Creek																														
71B	µg/L																													
A72	µg/L	160	46.9 J	46.9	87	0.54	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.4	1.4	0.60	2.3	<1.00 U	0.5	109	0.00	2.87	2.87	13	0.2	338	338	1000	0.3
A73	µg/L	151	23.3 J	23.3	87	0.27	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.374	0.374	0.58	0.6	<1.00 U	0.5	104	0.00	1.18	1.18	13	0.1	<100 U	50	1000	0.1
A73B	µg/L	49	<20.0 U	10	87	0.11	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	<0.100 U	0.05	0.25	0.2	<1.00 U	0.5	41	0.01	0.915 J	0.915	4.9	0.2	<100 U	50	1000	0.1
A75D	µg/L	96	40 J	40	87	0.46	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.786	0.786	0.41	1.9	<1.00 U	0.5	72	0.01	2.6	2.6	8.6	0.3	107 J	107	1000	0.1
A75B	µg/L																													
Bakers Bridge	µg/L	271	35.2 J	35.2	87	0.4	3.74	3.74	150	0.02	<2.00 U	1.0	0.66	1.5	<0.100 U	0.5	0.90	0.6	3.23	3.23	168	0.02	<0.500 U	0.25	21	0.0	1260	1260	1000	1.3
mainstem Cement Creek																														
CC48	µg/L																													
CC49	µg/L																													
mainstem Mineral Creek																														
M34	µg/L	139	45.7 J	45.7	87	0.53	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.127 J	0.127	0.54	0.2	<1.00 U	0.5	97	0.01	1.18	1.18	12	0.1	<100 U	50	1000	0.1

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: $((1.101672-\ln \text{hardness})*0.041838)*e^{(0.7988*\ln \text{hardness})-4.4451}$
the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$
the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

Sample Location	Units	Hardness (mg/L)	Lead				Manganese			Nickel				Selenium				Silver				Zinc		
Animas River above mainstem Cement Creek					BM	HQ		BM	HQ			BM	HQ			BM	HQ			BM	HQ		BM	HQ
A56 ("upstream")	µg/L	129	0.523	0.523	3.3	0.16	689	1796	0.38	<0.500 U	0.25	65	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.1	463	##	3.0
A60	µg/L	340	<0.500 U	0.25	9.3	0.03	6.46	2480	0.00	<2.50 U	1.25	##	0.01	<5.00 U	2.5	4.6	0.5	<2.50 U	1.25	0.6	2.0	1630	##	4.4
A61	µg/L	497	65.6 D	65.6	13.6	4.8	63800 D	2813	22.7	37.8 D	37.8	##	0.19	<7.5 U	3.8	4.6	0.8	<3.8 U	1.9	1.2	1.6	18490 D	##	35.5
A64	µg/L										13.4													
A65	µg/L	389	0.579 JD	0.579	10.6	0.05	16200	2594	6.25	13.4 D	0.25	##	0.00	<5.00 U	2.5	4.6	0.5	<2.50 U	1.25	0.8	1.6	4760	##	11.4
A66	µg/L	118	<0.100 U	0.05	3.0	0.02	2.57 J	1743	0.00	<0.500 U	0.25	60	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.5	179	##	1.3
A68	µg/L	121	0.258	0.258	3.1	0.08	590	1758	0.34	<0.500 U		61	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	2.4	294	##	2.0
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																								
A69A	µg/L																							
A70B	µg/L																							
Animas River below mainstem Mineral Creek																								
71B	µg/L																							
A72	µg/L	160	<0.100 U	0.05	4.2	0.01	995	1929	0.52	1.31	1.31	77	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.2	1.5	407	##	2.2
A73	µg/L	151	<0.100 U	0.05	3.9	0.01	2.45 J	1892	0.00	1.35	1.35	74	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.2	1.6	362	##	2.1
A73B	µg/L	49	<0.100 U	0.05	1.1	0.04	3.37 J	1301	0.00	0.581 J	0.581	28	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.02	11.4	32.9	63	0.5
A75D	µg/L	96	0.205	0.205	2.4	0.09	290	1627	0.18	1.52	1.52	50	0.03	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	3.6	190	##	1.6
A75B	µg/L																							
Bakers Bridge	µg/L	271	0.193 J	0.193	7.3	0.03	5870	2299	2.6	0.85 J	0.85	##	0.01	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.4	0.6	13.3 J	##	0.0
mainstem Cement Creek																								
CC48	µg/L																							
CC49	µg/L																							
mainstem Mineral Creek																								
M34	µg/L	139	<0.100 U	0.05	3.6	0.01	27.6	1841	0.01	<0.500 U	0.25	69	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.1	1.9	48.2	##	0.3

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for cadmium were calculated using the following equation: $((1.101672-\ln \text{hardness})*0.041838)*e^{(0.7988*\ln \text{hardness})-4.4451}$
the hardness-specific chronic surface water benchmarks for chromium were calculated using the following equation: $e^{(0.819*\ln \text{hardness})+0.534}$
the hardness-specific chronic surface water benchmarks for copper were calculated using the following equation: $e^{(0.854*\ln \text{hardness})-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln \text{hardness})+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln \text{hardness})+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln \text{hardness})*0.145712)*e^{(1.273*\ln \text{hardness})-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln \text{hardness})-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.9094*\ln \text{hardness})+0.6235)}$

prepared by: SJP (2/22/15)
reviewed by:

prepared by: SJP (2/16/15)

Appendix 8.1: Calculating sample-specific HQs for dissolved metals in pore water samples collected in April 2014
Baseline Ecological Risk Assessment
Upper Animas River Mining District

Sample Location	Units	Hardness (mg/L)	Aluminum		BM	HQ	Arsenic		BM	HQ	Beryllium		BM	HQ	Cadmium	BM	HQ	Chromium		BM	HQ	Copper	BM	HQ	Iron		BM	HQ
Animas River above mainstem Cement Creek																												
A56 ("upstream")	µg/L	136	23.8 J	23.8	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.232	0.53	0.4	<1.00 U	0.5	95	0.01	1.3	12	0.1	<100 U	50	1000	0.05
A60	µg/L	158	20.9 J	20.9	87	0.2	0.547 J	0.547	150	0.00	<2.00 U	1.0	0.66	1.5	0.809	0.60	1.4	<1.00 U	0.5	108	0.00	1.41	13	0.1	<100 U	50	1000	0.05
A61	µg/L	853	6170 D	6170	87	70.9	<5.00 U	2.5	150	0.02	<20.0 U	10.0	0.66	15	100 D	2.12	47.1	<10.0 U	5.0	429	0.01	2250 D	56	40.2	<1000 U	500	1000	0.5
A64	µg/L	141	<20.0 U	10	87	0.1	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.279	0.55	0.5	<1.00 U	0.5	98	0.01	1.83	12	0.2	<100 U	50	1000	0.05
A65	µg/L	350	671	671	87	7.7	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	22.4	1.09	20.6	0.8 J	0.8	207	0.00	53.8	26	2.1	<100 U	50	1000	0.05
A66	µg/L	141	<20.0 U	10	87	0.1	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.546	0.55	1.0	1.83 J	1.83	98	0.02	1.4	12	0.1	<100 U	50	1000	0.05
A68	µg/L	149	42.2 J	42.2	87	0.5	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	1.67	0.57	2.9	<1.00 U	0.5	103	0.00	3.46	13	0.3	<100 U	50	1000	0.05
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																												
A69A	µg/L																											
A70B	µg/L																											
Animas River below mainstem Mineral Creek																												
A71B																												
A72	µg/L	256	517	517	87	5.9	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	2.98	0.86	3.5	<1.00 U	0.5	160	0.00	8.07	20	0.4	<100 U	50	1000	0.05
A73	µg/L	185	29.2 J	29.2	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	2.03	0.67	3.0	<1.00 U	0.5	123	0.00	2.28	15	0.2	341	341	1000	0.341
A73B	µg/L																											
A75D	µg/L	135	27.7 J	27.7	87	0.3	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.387	0.53	0.7	<1.00 U	0.5	95	0.01	1.67	12	0.1	<100 U	50	1000	0.05
A75B	µg/L																											
Bakers Bridge	µg/L	125	47 J	47	87	0.5	<0.500 U	0.25	150	0.00	<2.00 U	1.0	0.66	1.5	0.334	0.50	0.7	1.15 J	1.15	89	0.01	2.21	11	0.2	<100 U	50	1000	0.05
mainstem Cement Creek																												
CC48	µg/L																											
CC49	µg/L																											
mainstem Mineral Creek																												
M34	µg/L																											

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for dissolved cadmium were calculated using the following equation: $((1.101672-\ln hardness)*0.041838)*e^{(0.7988*\ln hardness)-4.4451}$
the hardness-specific chronic surface water benchmarks for dissolved chromium were calculated using the following equation: $e^{(0.819*\ln hardness)+0.534}$
the hardness-specific chronic surface water benchmarks for dissolved copper were calculated using the following equation: $e^{(0.854*\ln hardness)-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln hardness)+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln hardness)+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln hardness)*0.145712)*e^{(1.273*\ln hardness)-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln hardness)-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.8094*\ln hardness)+0.6235)}$

Sample Location	Units	Hardness (mg/L)	Lead		BM	HQ	Manganese		BM	HQ	Nickel		BM	HQ	Selenium		BM	HQ	Silver		BM	HQ	Zinc	BM	HQ
Animas River above mainstem Cement Creek																									
A56 ("upstream")	µg/L	136	0.964	0.964	3.5	0.27	4.87 J	4.87	1828	0.00	<0.500 U	0.25	67	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.13	2.0	124	160	0.8
A60	µg/L	158	<0.100 U	0.05	4.1	0.01	<2.00 U	1.0	1921	0.00	<0.500 U	0.25	77	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.16	1.5	353	184	1.9
A61	µg/L	853	13.4 D	13.4	23.3	0.57	78300 D	78300	3369	23.24	77.5 D	77.5	319	0.24	<10.0 U	5.0	4.6	1.1	<5.00 U	2.5	3.00	0.8	29900 D	851	35.1
A64	µg/L	141	<0.100 U	0.05	3.7	0.01	4.27 J	4.27	1850	0.00	<0.500 U	0.25	70	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.14	1.8	264	166	1.6
A65	µg/L	350	2.00	2.00	9.5	0.21	18450	18450	2503	7.37	11.3	11.3	150	0.08	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.65	0.4	6230	378	16.5
A66	µg/L	141	0.123 J	0.123	3.7	0.03	226	226	1850	0.12	<0.500 U	0.25	70	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.14	1.8	307	166	1.9
A68	µg/L	149	<0.100 U	0.05	3.9	0.01	1540	1540	1884	0.82	<0.500 U	0.25	73	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.15	1.7	675	174	3.9
Animas River between mainstem Cement Creek and mainstem Mineral Crreek																									
A69A	µg/L																								
A70B	µg/L																								
Animas River below mainstem Mineral Creek																									
A71B																									
A72	µg/L	256	0.453	0.453	6.9	0.07	448	448	2256	0.20	1.95	1.95	115	0.02	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.38	0.7	1630	285	5.7
A73	µg/L	185	<0.100 U	0.05	4.9	0.01	1870	1870	2025	0.92	1.19	1.19	88	0.01	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.22	1.2	709	212	3.3
A73B	µg/L																								
A75D	µg/L	135	<0.100 U	0.05	3.5	0.01	185	185	1823	0.10	<0.500 U	0.25	67	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.13	2.0	173	159	1.1
A75B	µg/L																								
Bakers Bridge	µg/L	125	<0.100 U	0.05	3.2	0.02	325	325	1777	0.18	<0.500 U	0.25	63	0.00	<1.00 U	0.5	4.6	0.1	<0.500 U	0.25	0.11	2.3	115	148	0.8
mainstem Cement Creek																									
CC48	µg/L																								
CC49	µg/L																								
mainstem Mineral Creek																									
M34	µg/L																								

BM = benchmark; HQ = hazard quotient

the hardness-specific chronic surface water benchmarks for dissolved chromium were calculated using the following equation: $e^{(0.819*\ln hardness)+0.534}$
the hardness-specific chronic surface water benchmarks for dissolved copper were calculated using the following equation: $e^{(0.854*\ln hardness)-1.7428}$
the hardness-specific chronic surface water benchmarks for dissolved manganese were calculated using the following equation: $e^{(0.3331*\ln hardness)+5.8743}$
the hardness-specific chronic surface water benchmarks for dissolved nickel were calculated using the following equation: $e^{(0.846*\ln hardness)+0.0554}$
the hardness-specific chronic surface water benchmarks for dissolved lead were calculated using the following equation: $((1.46203-\ln hardness)*0.145712)*e^{(1.273*\ln hardness)-4.705}$
the hardness-specific chronic surface water benchmarks for dissolved silver were calculated using the following equation: $e^{(1.72*\ln hardness)-10.51}$
the hardness-specific chronic surface water benchmarks for dissolved zinc were calculated using the following equation: $0.986*e^{((0.8094*\ln hardness)+0.6235)}$

prepared by: SJP (2/22/15)
reviewed by:

ProUCL calculations for total Cd in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	0.8	Mean	1.382
Maximum	4	Median	1.3
SD	0.632	Std. Error of Mean	0.1
Coefficient of Variation	0.458	Skewness	2.637
Normal GOF Test			
Shapiro Wilk Test Statistic	0.719	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.55	95% Adjusted-CLT UCL (Chen-1995)	1.591
		95% Modified-t UCL (Johnson-1978)	1.557
Gamma GOF Test			
A-D Test Statistic	1.681	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.175	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.14	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.296	k star (bias corrected MLE)	6.766
Theta hat (MLE)	0.189	Theta star (bias corrected MLE)	0.204
nu hat (MLE)	583.7	nu star (bias corrected)	541.3
MLE Mean (bias corrected)	1.382	MLE Sd (bias corrected)	0.531
		Approximate Chi Square Value (0.05)	488.3
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	486.4
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.532	95% Adjusted Gamma UCL (use when n<50)	1.538
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.144	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.223	Mean of logged Data	0.253
Maximum of Logged Data	1.386	SD of logged Data	0.351
Assuming Lognormal Distribution			
95% H-UCL	1.518	90% Chebyshev (MVUE) UCL	1.601
95% Chebyshev (MVUE) UCL	1.707	97.5% Chebyshev (MVUE) UCL	1.853
99% Chebyshev (MVUE) UCL	2.142		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.546	95% Jackknife UCL	1.55
95% Standard Bootstrap UCL	1.546	95% Bootstrap-t UCL	1.64
95% Hall's Bootstrap UCL	1.733	95% Percentile Bootstrap UCL	1.552
95% BCA Bootstrap UCL	1.587		
90% Chebyshev(Mean, Sd) UCL	1.682	95% Chebyshev(Mean, Sd) UCL	1.818
97.5% Chebyshev(Mean, Sd) UCL	2.006	99% Chebyshev(Mean, Sd) UCL	2.377
Suggested UCL to Use			
95% Student's-t UCL	1.55	or 95% Modified-t UCL	1.557

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu in the Animas River above mainstem Cement Creek

User Selected Options			
Date/Time of Computation	2/19/2015 9:04		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	40	Number of Distinct Observations	31
Number of Detects	32	Number of Non-Detects	8
Number of Distinct Detects	29	Number of Distinct Non-Detects	3
Minimum Detect	3.9	Minimum Non-Detect	4
Maximum Detect	33.5	Maximum Non-Detect	20
Variance Detects	120.4	Percent Non-Detects	20%
Mean Detects	15.53	SD Detects	10.97
Median Detects	12.8	CV Detects	0.707
Skewness Detects	0.274	Kurtosis Detects	-1.67
Mean of Logged Detects	2.436	SD of Logged Detects	0.835

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.825	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.24	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.157	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	13.43	Standard Error of Mean	1.705
SD	10.57	95% KM (BCA) UCL	16.2
95% KM (t) UCL	16.3	95% KM (Percentile Bootstrap) UCL	16.4
95% KM (z) UCL	16.23	95% KM Bootstrap t UCL	16.41
90% KM Chebyshev UCL	18.54	95% KM Chebyshev UCL	20.86
97.5% KM Chebyshev UCL	24.07	99% KM Chebyshev UCL	30.39

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.253	Anderson-Darling GOF Test	
5% A-D Critical Value	0.761	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.225	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.158	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.78	k star (bias corrected MLE)	1.634
Theta hat (MLE)	8.72	Theta star (bias corrected MLE)	9.499
nu hat (MLE)	113.9	nu star (bias corrected)	104.6
MLE Mean (bias corrected)	15.53	MLE Sd (bias corrected)	12.14

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.613	nu hat (KM)	129.1
Approximate Chi Square Value (129.05, α)	103.8	Adjusted Chi Square Value (129.05, β)	103
95% Gamma Approximate KM-UCL (use when n>=50)	16.69	95% Gamma Adjusted KM-UCL (use when n<50)	16.83

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.632	Mean	13.49
Maximum	33.5	Median	7.958
SD	10.73	CV	0.796
k hat (MLE)	1.458	k star (bias corrected MLE)	1.366
Theta hat (MLE)	9.249	Theta star (bias corrected MLE)	9.877
nu hat (MLE)	116.7	nu star (bias corrected)	109.2
MLE Mean (bias corrected)	13.49	MLE Sd (bias corrected)	11.54
		Adjusted Level of Significance (β)	0.044
Approximate Chi Square Value (109.24, α)	86.12	Adjusted Chi Square Value (109.24, β)	85.35
95% Gamma Approximate UCL (use when n>=50)	17.11	95% Gamma Adjusted UCL (use when n<50)	17.26

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.819	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.157	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.43	Mean in Log Scale	2.248
SD in Original Scale	10.72	SD in Log Scale	0.87
95% t UCL (assumes normality of ROS data)	16.29	95% Percentile Bootstrap UCL	16.25
95% BCA Bootstrap UCL	16.1	95% Bootstrap t UCL	16.49
95% H-UCL (Log ROS)	18.95		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	13.77	Mean in Log Scale	2.294
SD in Original Scale	10.52	SD in Log Scale	0.852
95% t UCL (Assumes normality)	16.57	95% H-Stat UCL	19.37

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	16.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	1.4	Mean	11.57
Maximum	52.3	Median	2.85
SD	15.03	Std. Error of Mean	2.376
Coefficient of Variation	1.299	Skewness	1.732
Normal GOF Test			
Shapiro Wilk Test Statistic	0.69	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	15.57	95% Adjusted-CLT UCL (Chen-1995)	16.17
		95% Modified-t UCL (Johnson-1978)	15.68
Gamma GOF Test			
A-D Test Statistic	2.903	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.787	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.145	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.796	k star (bias corrected MLE)	0.753
Theta hat (MLE)	14.53	Theta star (bias corrected MLE)	15.36
nu hat (MLE)	63.69	nu star (bias corrected)	60.25
MLE Mean (bias corrected)	11.57	MLE Sd (bias corrected)	13.33
		Approximate Chi Square Value (0.05)	43.4
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	42.86
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	16.06	95% Adjusted Gamma UCL (use when n<50)	16.26
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.336	Mean of logged Data	1.703
Maximum of Logged Data	3.957	SD of logged Data	1.21
Assuming Lognormal Distribution			
95% H-UCL	19.12	90% Chebyshev (MVUE) UCL	18.84
95% Chebyshev (MVUE) UCL	22.37	97.5% Chebyshev (MVUE) UCL	27.25
99% Chebyshev (MVUE) UCL	36.85		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	15.48	95% Jackknife UCL	15.57
95% Standard Bootstrap UCL	15.41	95% Bootstrap-t UCL	16.6
95% Hall's Bootstrap UCL	15.85	95% Percentile Bootstrap UCL	15.66
95% BCA Bootstrap UCL	16.02		
90% Chebyshev(Mean, Sd) UCL	18.7	95% Chebyshev(Mean, Sd) UCL	21.93
97.5% Chebyshev(Mean, Sd) UCL	26.41	99% Chebyshev(Mean, Sd) UCL	35.22
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	21.93		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn in the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	39
		Number of Missing Observations	0
Minimum	252	Mean	432
Maximum	1180	Median	382
SD	202.5	Std. Error of Mean	32.01
Coefficient of Variation	0.469	Skewness	2.21
Normal GOF Test			
Shapiro Wilk Test Statistic	0.755	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.187	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	485.9	95% Adjusted-CLT UCL (Chen-1995)	496.6
		95% Modified-t UCL (Johnson-1978)	487.8
Gamma GOF Test			
A-D Test Statistic	1.516	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.14	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.606	k star (bias corrected MLE)	6.127
Theta hat (MLE)	65.4	Theta star (bias corrected MLE)	70.51
nu hat (MLE)	528.4	nu star (bias corrected)	490.1
MLE Mean (bias corrected)	432	MLE Sd (bias corrected)	174.5
		Approximate Chi Square Value (0.05)	439.8
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	438
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	481.4	95% Adjusted Gamma UCL (use when n<50)	483.4
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.115	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.529	Mean of logged Data	5.991
Maximum of Logged Data	7.073	SD of logged Data	0.373
Assuming Lognormal Distribution			
95% H-UCL	478	90% Chebyshev (MVUE) UCL	505.4
95% Chebyshev (MVUE) UCL	540.6	97.5% Chebyshev (MVUE) UCL	589.4
99% Chebyshev (MVUE) UCL	685.4		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	484.6	95% Jackknife UCL	485.9
95% Standard Bootstrap UCL	484.3	95% Bootstrap-t UCL	507.2
95% Hall's Bootstrap UCL	511.2	95% Percentile Bootstrap UCL	483.4
95% BCA Bootstrap UCL	494.5		
90% Chebyshev(Mean, Sd) UCL	528	95% Chebyshev(Mean, Sd) UCL	571.5
97.5% Chebyshev(Mean, Sd) UCL	631.9	99% Chebyshev(Mean, Sd) UCL	750.5
Suggested UCL to Use			
95% Student's-t UCL	485.9	or 95% Modified-t UCL	487.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:12
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	24	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.8	Mean	1.648
Maximum	2.9	Median	1.675
SD	0.683	Std. Error of Mean	0.139
Coefficient of Variation	0.415	Skewness	0.494
Normal GOF Test			
Shapiro Wilk Test Statistic	0.91	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.887	95% Adjusted-CLT UCL (Chen-1995)	1.892
		95% Modified-t UCL (Johnson-1978)	1.889
Gamma GOF Test			
A-D Test Statistic	0.539	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.138	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.085	k star (bias corrected MLE)	5.353
Theta hat (MLE)	0.271	Theta star (bias corrected MLE)	0.308
nu hat (MLE)	292.1	nu star (bias corrected)	256.9
MLE Mean (bias corrected)	1.648	MLE Sd (bias corrected)	0.712
		Approximate Chi Square Value (0.05)	220.8
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	218.5
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.917	95% Adjusted Gamma UCL (use when n<50)	1.938
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.14	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.223	Mean of logged Data	0.415
Maximum of Logged Data	1.065	SD of logged Data	0.424
Assuming Lognormal Distribution			
95% H-UCL	1.963	90% Chebyshev (MVUE) UCL	2.092
95% Chebyshev (MVUE) UCL	2.292	97.5% Chebyshev (MVUE) UCL	2.569
99% Chebyshev (MVUE) UCL	3.114		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.877	95% Jackknife UCL	1.887
95% Standard Bootstrap UCL	1.868	95% Bootstrap-t UCL	1.901
95% Hall's Bootstrap UCL	1.883	95% Percentile Bootstrap UCL	1.881
95% BCA Bootstrap UCL	1.898		
90% Chebyshev(Mean, Sd) UCL	2.066	95% Chebyshev(Mean, Sd) UCL	2.256
97.5% Chebyshev(Mean, Sd) UCL	2.519	99% Chebyshev(Mean, Sd) UCL	3.036
Suggested UCL to Use			
95% Student's-t UCL	1.887		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	24	Number of Distinct Observations	24
Number of Detects	23	Number of Non-Detects	1
Number of Distinct Detects	23	Number of Distinct Non-Detects	1
Minimum Detect	10.3	Minimum Non-Detect	20
Maximum Detect	46.7	Maximum Non-Detect	20
Variance Detects	117	Percent Non-Detects	4.17%
Mean Detects	27.36	SD Detects	10.82
Median Detects	28.8	CV Detects	0.395
Skewness Detects	-0.0118	Kurtosis Detects	-1.226
Mean of Logged Detects	3.222	SD of Logged Detects	0.446

Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.15	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.185	Detected Data appear Normal at 5% Significance Level	
Detected Data appear Normal at 5% Significance Level			

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	26.84	Standard Error of Mean	2.229
SD	10.66	95% KM (BCA) UCL	30.43
95% KM (t) UCL	30.66	95% KM (Percentile Bootstrap) UCL	30.38
95% KM (z) UCL	30.51	95% KM Bootstrap t UCL	30.67
90% KM Chebyshev UCL	33.53	95% KM Chebyshev UCL	36.56
97.5% KM Chebyshev UCL	40.76	99% KM Chebyshev UCL	49.02

Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.594	Anderson-Darling GOF Test	
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.175	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.182	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics on Detected Data Only			
k hat (MLE)	5.898	k star (bias corrected MLE)	5.158
Theta hat (MLE)	4.638	Theta star (bias corrected MLE)	5.304
nu hat (MLE)	271.3	nu star (bias corrected)	237.3
MLE Mean (bias corrected)	27.36	MLE Sd (bias corrected)	12.05

Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	6.342	nu hat (KM)	304.4
Approximate Chi Square Value (304.43, α)	265	Adjusted Chi Square Value (304.43, β)	262.4
95% Gamma Approximate KM-UCL (use when n>=50)	30.84	95% Gamma Adjusted KM-UCL (use when n<50)	31.14

Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	10.3	Mean	26.92
Maximum	46.7	Median	27.4
SD	10.79	CV	0.401
k hat (MLE)	5.867	k star (bias corrected MLE)	5.162
Theta hat (MLE)	4.588	Theta star (bias corrected MLE)	5.215
nu hat (MLE)	281.6	nu star (bias corrected)	247.8
MLE Mean (bias corrected)	26.92	MLE Sd (bias corrected)	11.85
		Adjusted Level of Significance (β)	0.0392
Approximate Chi Square Value (247.76, α)	212.3	Adjusted Chi Square Value (247.76, β)	210
95% Gamma Approximate UCL (use when n>=50)	31.41	95% Gamma Adjusted UCL (use when n<50)	31.75

Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.177	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.185	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			

Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	26.89	Mean in Log Scale	3.203
SD in Original Scale	10.82	SD in Log Scale	0.445
95% t UCL (assumes normality of ROS data)	30.68	95% Percentile Bootstrap UCL	30.28
95% BCA Bootstrap UCL	30.62	95% Bootstrap t UCL	30.81
95% H-UCL (Log ROS)	32.52		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed			
KM Mean (logged)	3.2	95% H-UCL (KM -Log)	32.29
KM SD (logged)	0.441	95% Critical H Value (KM-Log)	1.93
KM Standard Error of Mean (logged)	0.0926		

DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	26.63	Mean in Log Scale	3.183
SD in Original Scale	11.16	SD in Log Scale	0.474
95% t UCL (Assumes normality)	30.54	95% H-Stat UCL	32.78
DL/2 is not a recommended method, provided for comparisons and historical reasons			

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	30.66	95% KM (Percentile Bootstrap) UCL	30.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	24	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	3.3	Mean	12.77
Maximum	99.8	Median	5.9
SD	19.88	Std. Error of Mean	4.057
Coefficient of Variation	1.556	Skewness	3.983
Normal GOF Test			
Shapiro Wilk Test Statistic	0.465	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.321	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.181	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.73	95% Adjusted-CLT UCL (Chen-1995)	22.97
		95% Modified-t UCL (Johnson-1978)	20.27
Gamma GOF Test			
A-D Test Statistic	2.5	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.182	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.22	k star (bias corrected MLE)	1.095
Theta hat (MLE)	10.47	Theta star (bias corrected MLE)	11.66
nu hat (MLE)	58.56	nu star (bias corrected)	52.57
MLE Mean (bias corrected)	12.77	MLE Sd (bias corrected)	12.2
		Approximate Chi Square Value (0.05)	36.91
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	35.99
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	18.19	95% Adjusted Gamma UCL (use when n<50)	18.65
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.181	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.194	Mean of logged Data	2.084
Maximum of Logged Data	4.603	SD of logged Data	0.812
Assuming Lognormal Distribution			
95% H-UCL	16.51	90% Chebyshev (MVUE) UCL	16.97
95% Chebyshev (MVUE) UCL	19.68	97.5% Chebyshev (MVUE) UCL	23.44
99% Chebyshev (MVUE) UCL	30.82		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	19.45	95% Jackknife UCL	19.73
95% Standard Bootstrap UCL	19.14	95% Bootstrap-t UCL	33.29
95% Hall's Bootstrap UCL	41.1	95% Percentile Bootstrap UCL	20.29
95% BCA Bootstrap UCL	24.4		
90% Chebyshev(Mean, Sd) UCL	24.94	95% Chebyshev(Mean, Sd) UCL	30.46
97.5% Chebyshev(Mean, Sd) UCL	38.11	99% Chebyshev(Mean, Sd) UCL	53.14
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	30.46		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Ni from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	24	Number of Distinct Observations	11
Number of Detects	9	Number of Non-Detects	15
Number of Distinct Detects	8	Number of Distinct Non-Detects	4
Minimum Detect	2	Minimum Non-Detect	0.7
Maximum Detect	7	Maximum Non-Detect	4
Variance Detects	2.893	Percent Non-Detects	62.50%
Mean Detects	4.967	SD Detects	1.701
Median Detects	5.2	CV Detects	0.342
Skewness Detects	-0.416	Kurtosis Detects	-0.606
Mean of Logged Detects	1.538	SD of Logged Detects	0.407
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.117	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data appear Normal at 5% Significance Level	
Detected Data appear Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	2.559	Standard Error of Mean	0.519
SD	2.219	95% KM (BCA) UCL	3.864
95% KM (t) UCL	3.449	95% KM (Percentile Bootstrap) UCL	3.713
95% KM (z) UCL	3.413	95% KM Bootstrap t UCL	3.397
90% KM Chebyshev UCL	4.116	95% KM Chebyshev UCL	4.822
97.5% KM Chebyshev UCL	5.801	99% KM Chebyshev UCL	7.724
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.298	Anderson-Darling GOF Test	
5% A-D Critical Value	0.722	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.28	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	7.879	k star (bias corrected MLE)	5.327
Theta hat (MLE)	0.63	Theta star (bias corrected MLE)	0.932
nu hat (MLE)	141.8	nu star (bias corrected)	95.88
MLE Mean (bias corrected)	4.967	MLE Sd (bias corrected)	2.152
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	1.331	nu hat (KM)	63.87
Approximate Chi Square Value (63.87, α)	46.48	Adjusted Chi Square Value (63.87, β)	45.44
95% Gamma Approximate KM-UCL (use when n>=50)	3.516	95% Gamma Adjusted KM-UCL (use when n<50)	3.597
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	2.633
Maximum	7	Median	2.056
SD	2.25	CV	0.854
k hat (MLE)	0.714	k star (bias corrected MLE)	0.652
Theta hat (MLE)	3.69	Theta star (bias corrected MLE)	4.038
nu hat (MLE)	34.25	nu star (bias corrected)	31.3
MLE Mean (bias corrected)	2.633	MLE Sd (bias corrected)	3.261
		Adjusted Level of Significance (β)	0.0392
Approximate Chi Square Value (31.30, α)	19.52	Adjusted Chi Square Value (31.30, β)	18.87
95% Gamma Approximate UCL (use when n>=50)	4.222	95% Gamma Adjusted UCL (use when n<50)	4.369
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.163	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	2.959	Mean in Log Scale	0.89
SD in Original Scale	1.945	SD in Log Scale	0.632
95% t UCL (assumes normality of ROS data)	3.639	95% Percentile Bootstrap UCL	3.589
95% BCA Bootstrap UCL	3.68	95% Bootstrap t UCL	3.771
95% H-UCL (Log ROS)	3.926		
UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed			
KM Mean (logged)	0.526	95% H-UCL (KM -Log)	4.152
KM SD (logged)	0.924	95% Critical H Value (KM-Log)	2.444
KM Standard Error of Mean (logged)	0.238		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.794	Mean in Log Scale	0.772
SD in Original Scale	2.035	SD in Log Scale	0.751
95% t UCL (Assumes normality)	3.506	95% H-Stat UCL	4.07
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	3.449	95% KM (Percentile Bootstrap) UCL	3.713

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A72 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 9:13
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	221	Mean	599.7
Maximum	1320	Median	531
SD	319.3	Std. Error of Mean	65.17
Coefficient of Variation	0.532	Skewness	0.766
Normal GOF Test			
Shapiro Wilk Test Statistic	0.912	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	711.4	95% Adjusted-CLT UCL (Chen-1995)	717.8
		95% Modified-t UCL (Johnson-1978)	713.1
Gamma GOF Test			
A-D Test Statistic	0.379	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.129	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.179	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.824	k star (bias corrected MLE)	3.373
Theta hat (MLE)	156.8	Theta star (bias corrected MLE)	177.8
nu hat (MLE)	183.5	nu star (bias corrected)	161.9
MLE Mean (bias corrected)	599.7	MLE Sd (bias corrected)	326.5
		Approximate Chi Square Value (0.05)	133.5
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	131.7
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	727.4	95% Adjusted Gamma UCL (use when n<50)	737.4
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.126	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.181	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.398	Mean of logged Data	6.26
Maximum of Logged Data	7.185	SD of logged Data	0.539
Assuming Lognormal Distribution			
95% H-UCL	758.5	90% Chebyshev (MVUE) UCL	808.1
95% Chebyshev (MVUE) UCL	902	97.5% Chebyshev (MVUE) UCL	1032
99% Chebyshev (MVUE) UCL	1288		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	706.9	95% Jackknife UCL	711.4
95% Standard Bootstrap UCL	708	95% Bootstrap-t UCL	729
95% Hall's Bootstrap UCL	716.9	95% Percentile Bootstrap UCL	705.5
95% BCA Bootstrap UCL	720.9		
90% Chebyshev(Mean, Sd) UCL	795.2	95% Chebyshev(Mean, Sd) UCL	883.8
97.5% Chebyshev(Mean, Sd) UCL	1007	99% Chebyshev(Mean, Sd) UCL	1248
Suggested UCL to Use			
95% Student's-t UCL	711.4		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.97	Mean	1.524
Maximum	2.2	Median	1.27
SD	0.619	Std. Error of Mean	0.277
Coefficient of Variation	0.406	Skewness	0.458

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.114	95% Adjusted-CLT UCL (Chen-1995)	2.04
		95% Modified-t UCL (Johnson-1978)	2.124
Gamma GOF Test			
A-D Test Statistic	0.579	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.731	k star (bias corrected MLE)	3.226
Theta hat (MLE)	0.197	Theta star (bias corrected MLE)	0.472
nu hat (MLE)	77.31	nu star (bias corrected)	32.26
MLE Mean (bias corrected)	1.524	MLE Sd (bias corrected)	0.849
		Approximate Chi Square Value (0.05)	20.27
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	16.26
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2.425	95% Adjusted Gamma UCL (use when n<50)	3.023
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.0305	Mean of logged Data	0.355
Maximum of Logged Data	0.788	SD of logged Data	0.405
Assuming Lognormal Distribution			
95% H-UCL	2.656	90% Chebyshev (MVUE) UCL	2.344
95% Chebyshev (MVUE) UCL	2.717	97.5% Chebyshev (MVUE) UCL	3.234
99% Chebyshev (MVUE) UCL	4.249		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.979	95% Jackknife UCL	2.114
95% Standard Bootstrap UCL	1.933	95% Bootstrap-t UCL	3.187
95% Hall's Bootstrap UCL	2.885	95% Percentile Bootstrap UCL	1.95
95% BCA Bootstrap UCL	1.956		
90% Chebyshev(Mean, Sd) UCL	2.355	95% Chebyshev(Mean, Sd) UCL	2.731
97.5% Chebyshev(Mean, Sd) UCL	3.253	99% Chebyshev(Mean, Sd) UCL	4.279

Suggested UCL to Use

95% Student's-t UCL	2.114

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	8.3	Mean	17.76
Maximum	22.8	Median	19.3
SD	5.983	Std. Error of Mean	2.676
Coefficient of Variation	0.337	Skewness	-1.196

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.202	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.46	95% Adjusted-CLT UCL (Chen-1995)	20.63
		95% Modified-t UCL (Johnson-1978)	23.23
Gamma GOF Test			
A-D Test Statistic	0.483	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.24	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.447	k star (bias corrected MLE)	3.512
Theta hat (MLE)	2.102	Theta star (bias corrected MLE)	5.057
nu hat (MLE)	84.47	nu star (bias corrected)	35.12
MLE Mean (bias corrected)	17.76	MLE Sd (bias corrected)	9.477
		Approximate Chi Square Value (0.05)	22.56
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.29
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	27.65	95% Adjusted Gamma UCL (use when n<50)	34.1
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.116	Mean of logged Data	2.817
Maximum of Logged Data	3.127	SD of logged Data	0.418
Assuming Lognormal Distribution			
95% H-UCL	32.07	90% Chebyshev (MVUE) UCL	27.89
95% Chebyshev (MVUE) UCL	32.41	97.5% Chebyshev (MVUE) UCL	38.68
99% Chebyshev (MVUE) UCL	51.01		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	22.16	95% Jackknife UCL	23.46
95% Standard Bootstrap UCL	21.83	95% Bootstrap-t UCL	21.74
95% Hall's Bootstrap UCL	20.58	95% Percentile Bootstrap UCL	21.34
95% BCA Bootstrap UCL	20.66		
90% Chebyshev(Mean, Sd) UCL	25.79	95% Chebyshev(Mean, Sd) UCL	29.42
97.5% Chebyshev(Mean, Sd) UCL	34.47	99% Chebyshev(Mean, Sd) UCL	44.38

Suggested UCL to Use

95% Student's-t UCL	23.46

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A73 in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	2.6	Mean	11.14
Maximum	33.7	Median	6.3
SD	12.87	Std. Error of Mean	5.756
Coefficient of Variation	1.155	Skewness	2.022

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.73	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.357	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.41	95% Adjusted-CLT UCL (Chen-1995)	26.17
		95% Modified-t UCL (Johnson-1978)	24.28
Gamma GOF Test			
A-D Test Statistic	0.419	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.688	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.363	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.291	k star (bias corrected MLE)	0.65
Theta hat (MLE)	8.628	Theta star (bias corrected MLE)	17.14
nu hat (MLE)	12.91	nu star (bias corrected)	6.498
MLE Mean (bias corrected)	11.14	MLE Sd (bias corrected)	13.82
		Approximate Chi Square Value (0.05)	1.899
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	1.005
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	38.11	95% Adjusted Gamma UCL (use when n<50)	72.03
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.956	Mean of logged Data	1.976
Maximum of Logged Data	3.517	SD of logged Data	0.989
Assuming Lognormal Distribution			
95% H-UCL	129.8	90% Chebyshev (MVUE) UCL	23.7
95% Chebyshev (MVUE) UCL	29.71	97.5% Chebyshev (MVUE) UCL	38.06
99% Chebyshev (MVUE) UCL	54.45		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	20.61	95% Jackknife UCL	23.41
95% Standard Bootstrap UCL	19.58	95% Bootstrap-t UCL	66.03
95% Hall's Bootstrap UCL	61.76	95% Percentile Bootstrap UCL	22
95% BCA Bootstrap UCL	22.6		
90% Chebyshev(Mean, Sd) UCL	28.41	95% Chebyshev(Mean, Sd) UCL	36.23
97.5% Chebyshev(Mean, Sd) UCL	47.08	99% Chebyshev(Mean, Sd) UCL	68.41

Suggested UCL to Use

95% Student's-t UCL	23.41

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn in surface water from A73 on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:09
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	352	Mean	520.6
Maximum	768	Median	426
SD	192.2	Std. Error of Mean	85.93
Coefficient of Variation	0.369	Skewness	0.626

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.289	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	703.8	95% Adjusted-CLT UCL (Chen-1995)	687.7
		95% Modified-t UCL (Johnson-1978)	707.8
Gamma GOF Test			
A-D Test Statistic	0.503	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.289	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	9.607	k star (bias corrected MLE)	3.976
Theta hat (MLE)	54.19	Theta star (bias corrected MLE)	130.9
nu hat (MLE)	96.07	nu star (bias corrected)	39.76
MLE Mean (bias corrected)	520.6	MLE Sd (bias corrected)	261.1
		Approximate Chi Square Value (0.05)	26.31
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	21.66
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	786.6	95% Adjusted Gamma UCL (use when n<50)	955.8
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.854	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.864	Mean of logged Data	6.202
Maximum of Logged Data	6.644	SD of logged Data	0.36
Assuming Lognormal Distribution			
95% H-UCL	833.3	90% Chebyshev (MVUE) UCL	769.8
95% Chebyshev (MVUE) UCL	883.1	97.5% Chebyshev (MVUE) UCL	1040
99% Chebyshev (MVUE) UCL	1349		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	661.9	95% Jackknife UCL	703.8
95% Standard Bootstrap UCL	645	95% Bootstrap-t UCL	1256
95% Hall's Bootstrap UCL	2521	95% Percentile Bootstrap UCL	651.6
95% BCA Bootstrap UCL	666.4		
90% Chebyshev(Mean, Sd) UCL	778.4	95% Chebyshev(Mean, Sd) UCL	895.2
97.5% Chebyshev(Mean, Sd) UCL	1057	99% Chebyshev(Mean, Sd) UCL	1376

Suggested UCL to Use

95% Student's-t UCL	703.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.3	Mean	9.425
Maximum	13.1	Median	10.15
SD	3.927	Std. Error of Mean	1.964
Coefficient of Variation	0.417	Skewness	-0.797

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.227	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	14.05	95% Adjusted-CLT UCL (Chen-1995)	11.82
		95% Modified-t UCL (Johnson-1978)	13.92
Gamma GOF Test			
A-D Test Statistic	0.346	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.262	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.149	k star (bias corrected MLE)	1.704
Theta hat (MLE)	1.533	Theta star (bias corrected MLE)	5.532
nu hat (MLE)	49.19	nu star (bias corrected)	13.63
MLE Mean (bias corrected)	9.425	MLE Sd (bias corrected)	7.221
		Approximate Chi Square Value (0.05)	6.319
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	20.33	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.459	Mean of logged Data	2.16
Maximum of Logged Data	2.573	SD of logged Data	0.502
Assuming Lognormal Distribution			
95% H-UCL	28.53	90% Chebyshev (MVUE) UCL	16.55
95% Chebyshev (MVUE) UCL	19.74	97.5% Chebyshev (MVUE) UCL	24.16
99% Chebyshev (MVUE) UCL	32.85		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	12.65	95% Jackknife UCL	14.05
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15.32	95% Chebyshev(Mean, Sd) UCL	17.98
97.5% Chebyshev(Mean, Sd) UCL	21.69	99% Chebyshev(Mean, Sd) UCL	28.96

Suggested UCL to Use

95% Student's-t UCL	14.05

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.7	Mean	5.45
Maximum	11.7	Median	4.2
SD	4.392	Std. Error of Mean	2.196
Coefficient of Variation	0.806	Skewness	1.428

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.889	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.282	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	10.62	95% Adjusted-CLT UCL (Chen-1995)	10.74
		95% Modified-t UCL (Johnson-1978)	10.88

Gamma GOF Test

A-D Test Statistic	0.236	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.199	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.216	k star (bias corrected MLE)	0.721
Theta hat (MLE)	2.459	Theta star (bias corrected MLE)	7.562
nu hat (MLE)	17.73	nu star (bias corrected)	5.766
MLE Mean (bias corrected)	5.45	MLE Sd (bias corrected)	6.42
		Approximate Chi Square Value (0.05)	1.521
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20.66	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.997	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.531	Mean of logged Data	1.453
Maximum of Logged Data	2.46	SD of logged Data	0.809

Assuming Lognormal Distribution

95% H-UCL	76.22	90% Chebyshev (MVUE) UCL	11.65
95% Chebyshev (MVUE) UCL	14.48	97.5% Chebyshev (MVUE) UCL	18.41
99% Chebyshev (MVUE) UCL	26.12		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.062	95% Jackknife UCL	10.62
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	12.04	95% Chebyshev(Mean, Sd) UCL	15.02
97.5% Chebyshev(Mean, Sd) UCL	19.16	99% Chebyshev(Mean, Sd) UCL	27.3

Suggested UCL to Use

95% Student's-t UCL	10.62

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A73B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:23
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	119	Mean	265.3
Maximum	557	Median	192.5
SD	197.8	Std. Error of Mean	98.89
Coefficient of Variation	0.746	Skewness	1.799

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.372	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	498	95% Adjusted-CLT UCL (Chen-1995)	523
		95% Modified-t UCL (Johnson-1978)	512.8
Gamma GOF Test			
A-D Test Statistic	0.446	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.344	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.996	k star (bias corrected MLE)	0.916
Theta hat (MLE)	88.55	Theta star (bias corrected MLE)	289.7
nu hat (MLE)	23.97	nu star (bias corrected)	7.325
MLE Mean (bias corrected)	265.3	MLE Sd (bias corrected)	277.2
		Approximate Chi Square Value (0.05)	2.35
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	826.6	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.303	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.779	Mean of logged Data	5.405
Maximum of Logged Data	6.323	SD of logged Data	0.654
Assuming Lognormal Distribution			
95% H-UCL	1521	90% Chebyshev (MVUE) UCL	506.8
95% Chebyshev (MVUE) UCL	618.7	97.5% Chebyshev (MVUE) UCL	774
99% Chebyshev (MVUE) UCL	1079		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	427.9	95% Jackknife UCL	498
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	561.9	95% Chebyshev(Mean, Sd) UCL	696.3
97.5% Chebyshev(Mean, Sd) UCL	882.8	99% Chebyshev(Mean, Sd) UCL	1249

Suggested UCL to Use

95% Student's-t UCL	498

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.51	Mean	1.013
Maximum	1.43	Median	0.924
SD	0.364	Std. Error of Mean	0.163
Coefficient of Variation	0.359	Skewness	-0.285

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.196	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.36	95% Adjusted-CLT UCL (Chen-1995)	1.258
		95% Modified-t UCL (Johnson-1978)	1.356

Gamma GOF Test

A-D Test Statistic	0.316	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.213	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.461	k star (bias corrected MLE)	3.518
Theta hat (MLE)	0.12	Theta star (bias corrected MLE)	0.288
nu hat (MLE)	84.61	nu star (bias corrected)	35.18
MLE Mean (bias corrected)	1.013	MLE Sd (bias corrected)	0.54
		Approximate Chi Square Value (0.05)	22.61
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.33

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.576	95% Adjusted Gamma UCL (use when n<50)	1.943

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.673	Mean of logged Data	-0.0475
Maximum of Logged Data	0.358	SD of logged Data	0.405

Assuming Lognormal Distribution			
95% H-UCL	1.776	90% Chebyshev (MVUE) UCL	1.567
95% Chebyshev (MVUE) UCL	1.816	97.5% Chebyshev (MVUE) UCL	2.162
99% Chebyshev (MVUE) UCL	2.841		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	1.281	95% Jackknife UCL	1.36
95% Standard Bootstrap UCL	1.255	95% Bootstrap-t UCL	1.437
95% Hall's Bootstrap UCL	1.486	95% Percentile Bootstrap UCL	1.251
95% BCA Bootstrap UCL	1.228		
90% Chebyshev(Mean, Sd) UCL	1.501	95% Chebyshev(Mean, Sd) UCL	1.722
97.5% Chebyshev(Mean, Sd) UCL	2.029	99% Chebyshev(Mean, Sd) UCL	2.632

Suggested UCL to Use

95% Student's-t UCL	1.36

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Cu from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/19/2015 10:41		
From File	WorkSheet_d.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics			
Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	4.4	Mean	13.8
Maximum	20.6	Median	13.5
SD	6.183	Std. Error of Mean	2.765
Coefficient of Variation	0.448	Skewness	-0.791

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.223	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.7	95% Adjusted-CLT UCL (Chen-1995)	17.3
		95% Modified-t UCL (Johnson-1978)	19.53
Gamma GOF Test			
A-D Test Statistic	0.42	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.29	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.36	k star (bias corrected MLE)	1.877
Theta hat (MLE)	3.165	Theta star (bias corrected MLE)	7.352
nu hat (MLE)	43.6	nu star (bias corrected)	18.77
MLE Mean (bias corrected)	13.8	MLE Sd (bias corrected)	10.07
		Approximate Chi Square Value (0.05)	9.951
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	7.311
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	26.03	95% Adjusted Gamma UCL (use when n<50)	35.43
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.838	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.318	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.482	Mean of logged Data	2.506
Maximum of Logged Data	3.025	SD of logged Data	0.607
Assuming Lognormal Distribution			
95% H-UCL	40.22	90% Chebyshev (MVUE) UCL	25.5
95% Chebyshev (MVUE) UCL	30.65	97.5% Chebyshev (MVUE) UCL	37.79
99% Chebyshev (MVUE) UCL	51.82		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	18.35	95% Jackknife UCL	19.7
95% Standard Bootstrap UCL	17.84	95% Bootstrap-t UCL	19.07
95% Hall's Bootstrap UCL	18.42	95% Percentile Bootstrap UCL	17.76
95% BCA Bootstrap UCL	17.04		
90% Chebyshev(Mean, Sd) UCL	22.1	95% Chebyshev(Mean, Sd) UCL	25.85
97.5% Chebyshev(Mean, Sd) UCL	31.07	99% Chebyshev(Mean, Sd) UCL	41.31

Suggested UCL to Use

95% Student's-t UCL	19.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Pb from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.6	Mean	11.22
Maximum	32.6	Median	5.5
SD	12.44	Std. Error of Mean	5.562
Coefficient of Variation	1.108	Skewness	1.837

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.786	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.301	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.08	95% Adjusted-CLT UCL (Chen-1995)	25.25
		95% Modified-t UCL (Johnson-1978)	23.84
Gamma GOF Test			
A-D Test Statistic	0.306	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.689	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.246	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.363	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.196	k star (bias corrected MLE)	0.612
Theta hat (MLE)	9.379	Theta star (bias corrected MLE)	18.34
nu hat (MLE)	11.96	nu star (bias corrected)	6.119
MLE Mean (bias corrected)	11.22	MLE Sd (bias corrected)	14.34
		Approximate Chi Square Value (0.05)	1.701
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.875
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	40.36	95% Adjusted Gamma UCL (use when n<50)	78.47
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.47	Mean of logged Data	1.945
Maximum of Logged Data	3.484	SD of logged Data	1.108
Assuming Lognormal Distribution			
95% H-UCL	253.8	90% Chebyshev (MVUE) UCL	26.6
95% Chebyshev (MVUE) UCL	33.64	97.5% Chebyshev (MVUE) UCL	43.42
99% Chebyshev (MVUE) UCL	62.64		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	20.37	95% Jackknife UCL	23.08
95% Standard Bootstrap UCL	19.31	95% Bootstrap-t UCL	58.77
95% Hall's Bootstrap UCL	76.93	95% Percentile Bootstrap UCL	20.92
95% BCA Bootstrap UCL	22.9		
90% Chebyshev(Mean, Sd) UCL	27.9	95% Chebyshev(Mean, Sd) UCL	35.46
97.5% Chebyshev(Mean, Sd) UCL	45.95	99% Chebyshev(Mean, Sd) UCL	66.56

Suggested UCL to Use

95% Student's-t UCL	23.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A75D in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:41
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	181	Mean	360.6
Maximum	545	Median	306
SD	149.6	Std. Error of Mean	66.89
Coefficient of Variation	0.415	Skewness	0.22

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.933	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	503.2	95% Adjusted-CLT UCL (Chen-1995)	477.7
		95% Modified-t UCL (Johnson-1978)	504.3

Gamma GOF Test

A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.224	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.865	k star (bias corrected MLE)	2.879
Theta hat (MLE)	52.53	Theta star (bias corrected MLE)	125.2
nu hat (MLE)	68.65	nu star (bias corrected)	28.79
MLE Mean (bias corrected)	360.6	MLE Sd (bias corrected)	212.5
		Approximate Chi Square Value (0.05)	17.55
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	13.85

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	591.7	95% Adjusted Gamma UCL (use when n<50)	749.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.197	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.198	Mean of logged Data	5.813
Maximum of Logged Data	6.301	SD of logged Data	0.442

Assuming Lognormal Distribution

95% H-UCL	680.2	90% Chebyshev (MVUE) UCL	574.3
95% Chebyshev (MVUE) UCL	670.7	97.5% Chebyshev (MVUE) UCL	804.4
99% Chebyshev (MVUE) UCL	1067		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	470.6	95% Jackknife UCL	503.2
95% Standard Bootstrap UCL	458.1	95% Bootstrap-t UCL	607.3
95% Hall's Bootstrap UCL	828.2	95% Percentile Bootstrap UCL	459.8
95% BCA Bootstrap UCL	449.4		
90% Chebyshev(Mean, Sd) UCL	561.3	95% Chebyshev(Mean, Sd) UCL	652.2
97.5% Chebyshev(Mean, Sd) UCL	778.3	99% Chebyshev(Mean, Sd) UCL	1026

Suggested UCL to Use

95% Student's-t UCL	503.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.51	Mean	0.877
Maximum	1.1	Median	0.948
SD	0.258	Std. Error of Mean	0.129
Coefficient of Variation	0.295	Skewness	-1.402

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.18	95% Adjusted-CLT UCL (Chen-1995)	0.992
		95% Modified-t UCL (Johnson-1978)	1.165
Gamma GOF Test			
A-D Test Statistic	0.455	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.318	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	12.62	k star (bias corrected MLE)	3.322
Theta hat (MLE)	0.0695	Theta star (bias corrected MLE)	0.264
nu hat (MLE)	101	nu star (bias corrected)	26.57
MLE Mean (bias corrected)	0.877	MLE Sd (bias corrected)	0.481
		Approximate Chi Square Value (0.05)	15.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.472	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.322	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.673	Mean of logged Data	-0.172
Maximum of Logged Data	0.0953	SD of logged Data	0.345
Assuming Lognormal Distribution			
95% H-UCL	1.605	90% Chebyshev (MVUE) UCL	1.331
95% Chebyshev (MVUE) UCL	1.535	97.5% Chebyshev (MVUE) UCL	1.819
99% Chebyshev (MVUE) UCL	2.375		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.089	95% Jackknife UCL	1.18
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.264	95% Chebyshev(Mean, Sd) UCL	1.439
97.5% Chebyshev(Mean, Sd) UCL	1.683	99% Chebyshev(Mean, Sd) UCL	2.161

Suggested UCL to Use

95% Student's-t UCL	1.18

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for total Cu from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.1	Mean	12.18
Maximum	21.5	Median	11.55
SD	8.824	Std. Error of Mean	4.412
Coefficient of Variation	0.725	Skewness	0.129

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.85	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.285	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	22.56	95% Adjusted-CLT UCL (Chen-1995)	19.74
		95% Modified-t UCL (Johnson-1978)	22.61

Gamma GOF Test

A-D Test Statistic	0.484	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.305	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.182	k star (bias corrected MLE)	0.712
Theta hat (MLE)	5.579	Theta star (bias corrected MLE)	17.09
nu hat (MLE)	17.46	nu star (bias corrected)	5.698
MLE Mean (bias corrected)	12.18	MLE Sd (bias corrected)	14.43
		Approximate Chi Square Value (0.05)	1.488
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	46.63	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.848	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.273	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.411	Mean of logged Data	2.253
Maximum of Logged Data	3.068	SD of logged Data	0.844

Assuming Lognormal Distribution			
95% H-UCL	217.4	90% Chebyshev (MVUE) UCL	27.01
95% Chebyshev (MVUE) UCL	33.68	97.5% Chebyshev (MVUE) UCL	42.95
99% Chebyshev (MVUE) UCL	61.15		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	19.43	95% Jackknife UCL	22.56
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	25.41	95% Chebyshev(Mean, Sd) UCL	31.41
97.5% Chebyshev(Mean, Sd) UCL	39.73	99% Chebyshev(Mean, Sd) UCL	56.07

Suggested UCL to Use

95% Student's-t UCL	22.56

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.5	Mean	12.13
Maximum	34.5	Median	6.25
SD	15.46	Std. Error of Mean	7.73
Coefficient of Variation	1.275	Skewness	1.622

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.808	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.294	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.32	95% Adjusted-CLT UCL (Chen-1995)	31.54
		95% Modified-t UCL (Johnson-1978)	31.36

Gamma GOF Test

A-D Test Statistic	0.354	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.67	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.293	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.404	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.804	k star (bias corrected MLE)	0.368
Theta hat (MLE)	15.08	Theta star (bias corrected MLE)	32.98
nu hat (MLE)	6.432	nu star (bias corrected)	2.941
MLE Mean (bias corrected)	12.13	MLE Sd (bias corrected)	20
		Approximate Chi Square Value (0.05)	0.355
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	100.4	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.257	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.405	Mean of logged Data	1.758
Maximum of Logged Data	3.541	SD of logged Data	1.458

Assuming Lognormal Distribution			
95% H-UCL	54710	90% Chebyshev (MVUE) UCL	33.59
95% Chebyshev (MVUE) UCL	43.52	97.5% Chebyshev (MVUE) UCL	57.3
99% Chebyshev (MVUE) UCL	84.37		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	24.84	95% Jackknife UCL	30.32
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	35.31	95% Chebyshev(Mean, Sd) UCL	45.82
97.5% Chebyshev(Mean, Sd) UCL	60.4	99% Chebyshev(Mean, Sd) UCL	89.04

Suggested UCL to Use

95% Student's-t UCL	30.32

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from sampling location A75B in the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:47
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	183	Mean	301.8
Maximum	445	Median	289.5
SD	108	Std. Error of Mean	54.01
Coefficient of Variation	0.358	Skewness	0.665

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	428.9	95% Adjusted-CLT UCL (Chen-1995)	409.8
		95% Modified-t UCL (Johnson-1978)	431.9
Gamma GOF Test			
A-D Test Statistic	0.281	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.233	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	10.42	k star (bias corrected MLE)	2.771
Theta hat (MLE)	28.96	Theta star (bias corrected MLE)	108.9
nu hat (MLE)	83.35	nu star (bias corrected)	22.17
MLE Mean (bias corrected)	301.8	MLE Sd (bias corrected)	181.3
		Approximate Chi Square Value (0.05)	12.47
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	536.6	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.209	Mean of logged Data	5.661
Maximum of Logged Data	6.098	SD of logged Data	0.363
Assuming Lognormal Distribution			
95% H-UCL	578.3	90% Chebyshev (MVUE) UCL	464.7
95% Chebyshev (MVUE) UCL	538.5	97.5% Chebyshev (MVUE) UCL	640.9
99% Chebyshev (MVUE) UCL	842		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	390.6	95% Jackknife UCL	428.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	463.8	95% Chebyshev(Mean, Sd) UCL	537.2
97.5% Chebyshev(Mean, Sd) UCL	639.1	99% Chebyshev(Mean, Sd) UCL	839.2

Suggested UCL to Use

95% Student's-t UCL	428.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Cd from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options

Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.601	Minimum Non-Detect	0.5
Maximum Detect	0.8	Maximum Non-Detect	0.5
Variance Detects	0.00663	Percent Non-Detects	20%
Mean Detects	0.698	SD Detects	0.0814
Median Detects	0.695	CV Detects	0.117
Skewness Detects	0.219	Kurtosis Detects	1.436
Mean of Logged Detects	-0.365	SD of Logged Detects	0.117

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	95% UCLs (Adjusted for Skewness)	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.658	Standard Error of Mean	0.0522
SD	0.101	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.769	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.744	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.815	95% KM Chebyshev UCL	0.886
97.5% KM Chebyshev UCL	0.984	99% KM Chebyshev UCL	1.177

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.275	Anderson-Darling GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.222	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	97.81	k star (bias corrected MLE)	24.62
Theta hat (MLE)	0.00713	Theta star (bias corrected MLE)	0.0283
nu hat (MLE)	782.5	nu star (bias corrected)	197
MLE Mean (bias corrected)	0.698	MLE Sd (bias corrected)	0.141

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	42.36	nu hat (KM)	423.6
Approximate Chi Square Value (423.63, α)	376.9	Adjusted Chi Square Value (423.63, β)	357.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.74	95% Gamma Adjusted KM-UCL (use when n<50)	0.78

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.494	Mean	0.657
Maximum	0.8	Median	0.689
SD	0.115	CV	0.175
k hat (MLE)	38.64	k star (bias corrected MLE)	15.59
Theta hat (MLE)	0.017	Theta star (bias corrected MLE)	0.0421
nu hat (MLE)	386.4	nu star (bias corrected)	155.9
MLE Mean (bias corrected)	0.657	MLE Sd (bias corrected)	0.166
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (155.89, α)	128	Adjusted Chi Square Value (155.89, β)	117
95% Gamma Approximate UCL (use when n>=50)	0.8	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.967	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.66	Mean in Log Scale	-0.427
SD in Original Scale	0.109	SD in Log Scale	0.171
95% t UCL (assumes normality of ROS data)	0.764	95% Percentile Bootstrap UCL	0.736
95% BCA Bootstrap UCL	0.72	95% Bootstrap t UCL	0.765
95% H-UCL (Log ROS)	0.795		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.431	95% H-UCL (KM -Log)	0.78
KM SD (logged)	0.159	95% Critical H Value (KM-Log)	2.127
KM Standard Error of Mean (logged)	0.0823		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.608	Mean in Log Scale	-0.57
SD in Original Scale	0.212	SD in Log Scale	0.468
95% t UCL (Assumes normality)	0.81	95% H-Stat UCL	1.228

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.769	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Cu from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	2.8	Minimum Non-Detect	2.5
Maximum Detect	16.3	Maximum Non-Detect	2.5
Variance Detects	31.98	Percent Non-Detects	20%
Mean Detects	9.5	SD Detects	5.655
Median Detects	9.45	CV Detects	0.595
Skewness Detects	0.0477	Kurtosis Detects	0.0745
Mean of Logged Detects	2.071	SD of Logged Detects	0.755

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	N/A	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	95% UCLs (Adjusted for Skewness)	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	8.1	Standard Error of Mean	2.685
SD	5.199	95% KM (BCA) UCL	N/A
95% KM (t) UCL	13.82	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	12.52	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	16.15	95% KM Chebyshev UCL	19.8
97.5% KM Chebyshev UCL	24.87	99% KM Chebyshev UCL	34.81

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.244	Anderson-Darling GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.207	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.935	k star (bias corrected MLE)	0.9
Theta hat (MLE)	3.236	Theta star (bias corrected MLE)	10.55
nu hat (MLE)	23.48	nu star (bias corrected)	7.204
MLE Mean (bias corrected)	9.5	MLE Sd (bias corrected)	10.01

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.427	nu hat (KM)	24.27
Approximate Chi Square Value (24.27, α)	14.06	Adjusted Chi Square Value (24.27, β)	10.81
95% Gamma Approximate KM-UCL (use when n>=50)	13.99	95% Gamma Adjusted KM-UCL (use when n<50)	18.18

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.602
Maximum	16.3	Median	7.9
SD	6.481	CV	0.852
k hat (MLE)	0.493	k star (bias corrected MLE)	0.33
Theta hat (MLE)	15.43	Theta star (bias corrected MLE)	23.01
nu hat (MLE)	4.926	nu star (bias corrected)	3.304
MLE Mean (bias corrected)	7.602	MLE Sd (bias corrected)	13.23
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (3.30, α)	0.468	Adjusted Chi Square Value (3.30, β)	0.178
95% Gamma Approximate UCL (use when n>=50)	53.68	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.937	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.829	Mean in Log Scale	1.684
SD in Original Scale	6.161	SD in Log Scale	1.086
95% t UCL (assumes normality of ROS data)	13.7	95% Percentile Bootstrap UCL	11.88
95% BCA Bootstrap UCL	11.92	95% Bootstrap t UCL	14.32
95% H-UCL (Log ROS)	170.3		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.84	95% H-UCL (KM -Log)	34.78
KM SD (logged)	0.745	95% Critical H Value (KM-Log)	3.84
KM Standard Error of Mean (logged)	0.385		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.85	Mean in Log Scale	1.702
SD in Original Scale	6.132	SD in Log Scale	1.054
95% t UCL (Assumes normality)	13.7	95% H-Stat UCL	143.2

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	13.82	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for total Pb from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.6	Mean	7.78
Maximum	26	Median	5.4
SD	10.45	Std. Error of Mean	4.673
Coefficient of Variation	1.343	Skewness	1.961

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.739	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.379	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	17.74	95% Adjusted-CLT UCL (Chen-1995)	19.85
		95% Modified-t UCL (Johnson-1978)	18.43
Gamma GOF Test			
A-D Test Statistic	0.331	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.247	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.367	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.765	k star (bias corrected MLE)	0.439
Theta hat (MLE)	10.17	Theta star (bias corrected MLE)	17.71
nu hat (MLE)	7.652	nu star (bias corrected)	4.394
MLE Mean (bias corrected)	7.78	MLE Sd (bias corrected)	11.74
		Approximate Chi Square Value (0.05)	0.883
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.382
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	38.7	95% Adjusted Gamma UCL (use when n<50)	89.41
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.211	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.511	Mean of logged Data	1.271
Maximum of Logged Data	3.258	SD of logged Data	1.475
Assuming Lognormal Distribution			
95% H-UCL	1856	90% Chebyshev (MVUE) UCL	21.5
95% Chebyshev (MVUE) UCL	27.75	97.5% Chebyshev (MVUE) UCL	36.42
99% Chebyshev (MVUE) UCL	53.45		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	15.47	95% Jackknife UCL	17.74
95% Standard Bootstrap UCL	14.71	95% Bootstrap-t UCL	36.7
95% Hall's Bootstrap UCL	53.89	95% Percentile Bootstrap UCL	16.08
95% BCA Bootstrap UCL	17.76		
90% Chebyshev(Mean, Sd) UCL	21.8	95% Chebyshev(Mean, Sd) UCL	28.15
97.5% Chebyshev(Mean, Sd) UCL	36.97	99% Chebyshev(Mean, Sd) UCL	54.28

Suggested UCL to Use

95% Student's-t UCL	17.74

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for total Zn from Baker Bridge on the Animas River below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 10:55
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	126	Mean	215.8
Maximum	273	Median	221
SD	59.41	Std. Error of Mean	26.57
Coefficient of Variation	0.275	Skewness	-0.862

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	272.4	95% Adjusted-CLT UCL (Chen-1995)	248.6
		95% Modified-t UCL (Johnson-1978)	270.7
Gamma GOF Test			
A-D Test Statistic	0.35	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.14	k star (bias corrected MLE)	5.789
Theta hat (MLE)	15.26	Theta star (bias corrected MLE)	37.28
nu hat (MLE)	141.4	nu star (bias corrected)	57.89
MLE Mean (bias corrected)	215.8	MLE Sd (bias corrected)	89.69
		Approximate Chi Square Value (0.05)	41.4
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	35.39
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	301.8	95% Adjusted Gamma UCL (use when n<50)	353
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.217	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.836	Mean of logged Data	5.339
Maximum of Logged Data	5.609	SD of logged Data	0.312
Assuming Lognormal Distribution			
95% H-UCL	319.5	90% Chebyshev (MVUE) UCL	306.8
95% Chebyshev (MVUE) UCL	347.7	97.5% Chebyshev (MVUE) UCL	404.5
99% Chebyshev (MVUE) UCL	516.1		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	259.5	95% Jackknife UCL	272.4
95% Standard Bootstrap UCL	254.5	95% Bootstrap-t UCL	262.4
95% Hall's Bootstrap UCL	256.4	95% Percentile Bootstrap UCL	252.2
95% BCA Bootstrap UCL	245.2		
90% Chebyshev(Mean, Sd) UCL	295.5	95% Chebyshev(Mean, Sd) UCL	331.6
97.5% Chebyshev(Mean, Sd) UCL	381.7	99% Chebyshev(Mean, Sd) UCL	480.2

Suggested UCL to Use

95% Student's-t UCL	272.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Sediment data for Pro UCL

Sample Location	Arsenic		Beryllium		Cadmium		Copper		Lead		Manganese		Mercury		Selenium		Silver		Zinc		Cr		Ni		
Animas River above mainstem cement creek																									
A60	24.4	1	2.01	0	14.7	1	286	1	2100	1	12600	1			0.502	0	4.05	1	3180	1	4.97	1	8.95	1	May-12
A61	44.0	1.0	2.53	1	11.3	1	466	1	2120	1	11000	1			0.505	0	7.34	1	2840	1	5.69	1	16.5	1	Oct-12
A64	44.2	1	2.77	1	11.9	1	336	1	1770	1	9670	1			0.905	1	7.14	1	3470	1	4.86	1	7.58	1	May-13
A65	30.3	1	2.02	0	10.3	1	328	1	1840	1	12900	1			0.504	0	5.53	1	2590	1	4.71	1	7.19	1	
A66	26.9	1	1.99	0	8.44	1	257	1	1750	1	7830	1			0.497	0	5.06	1	1950	1	4.42	1	7.2	1	
A68	26.3	1	2.01	0	13.7	1	352	1	2180	1	10300	1			0.501	0	9.22	1	2830	1	4.76	1	6.68	1	
A68	25.9	1	2.01	0	13.4	1	374	1	1890	1	12200	1	0.081	D	1.29	1	7.09	1	3030	1	5.68	1	5.92	1	
A68	89.5	1	6.77	1	24.2	1	745	1	3030	1	22300	1	0.19	D	2.86	1	13.3	1	11500	1	5.21	1	8.76	1	
A60	16.4	1	2.01	0	5.84	1	166	1	554	1	3400	1	0.033	D	1.0	0	3.48	1	1530	1	6.35	1	9.62	1	Apr-14
A61	19.8	1	2.99	1	9.02	1	638	1	891	1	6400	1	0.091	D	1.1	1	4.28	1	2530	1	5.28	1	8.56	1	
A64	18.8	1	2.02	0	6.25	1	199	1	1050	1	4920	1	0.053	D	1.01	0	3.59	1	1950	1	5.15	1	7.44	1	
A65	21.8	1	2.16	1	10.2	1	331	1	900	1	10300	1	0.073	D	1.01	0	3.87	1	2890	1	5.49	1	9.9	1	
A66	18.3	1	2.24	1	18.3	1	378	1	1230	1	20500	1	0.06	D	1.0	0	4.13	1	4380	1	4.07	1	10.1	1	
A68	19.1	1	2.82	1	15.7	1	390	1	1080	1	19700	1	0.056	D	0.998	0	4.35	1	4890	1	4.21	1	10.3	1	
A60	20.4	1	2.03	0	9.55	1	262	1	1610	1	7460	1	0.07	D	1.02	0	5.96	1	2130	1	3.88	1	6.26	1	Sep-14
A61	20.5	1	2.1	1	4.95	1	286	1	1400	1	8210	1	0.05	D	0.995	0	5.23	1	2330	1	3.55	1	6.52	1	
A64	21.3	1	3.0	1	7.93	1	264	1	1120	1	6850	1	0.13	D	1.01	0	4.88	1	2730	1	3.55	1	6.84	1	
A65	19.4	1	1.99	0	6.82	1	271	1	1220	1	8180	1	0.03	D	0.997	0	3.61	1	1700	1	3.76	1	6.49	1	
A66	23.7	1	2.03	0	9.17	1	243	1	1190	1	8190	1	0.05	D	1.01	0	4.81	1	2500	1	3.7	1	7.11	1	
A68	17.5	1	1.97	0	10.8	1	216	1	1240	1	9430	1	0.02	JD	0.985	0	2.9	1	2480	1	3.73	1	6.56	1	
count	20		20		20		20		20		20		14		20		20		20						
Max	89.5	1	6.77	1	24.2	1	745	1	3030	1	22300	1	0.19	0	2.86	1	13.3	1	11500						
Min	16.4	1	1.97	0	4.95	1	166	1	554	1	3400	1	0.02	0	0.497	0	2.9	1	1530						

		aluminum		arsenic		beryllium		cadmium		copper		lead		manganese		nickel		selenium		silver		Zinc		Hg		Cr	
Animas River downstream of mainstem Mineral Creek																											
A72	May-12	12200	1	40.6	1	1.97	0	2.8	1	152	1	581	1	2710	1	6.38	1	2.03	1	1.99	1	748	1	0.072	1	6.1	1
A72	Oct-12	21500	1	36.3	1	2	0	1.81	1	179	1	542	1	1470	1	4.79	1	1.83	1	2.76	1	646	1	0.06	1	4.05	1
A72	May-13	11800	1	26.1	1	1.97	0	1.15	1	77.8	1	299	1	1210	1	4.88	1	1.04	1	1.3	1	386	1			6.41	1
A72	Apr-14	18900	1	37	1	2.0	0	1.7	1	145	1	470	1	1710	1	4.33	1	1.05	1	1.68	1	616	1	0.039	1	3.45	1
A72	Sep-14	9960	1	26.8	1	2.03	0	3.03	1	133	1	499	1	3400	1	5.33	1	1.02	0	1.83	1	858	1	0.05	1	3.01	1
A73	Oct-12	11800	1	25.5	1	1.97	0	3.64	1	223	1	729	1	4140	1	6.84	1	1.43	1	2.32	1	1000	1	0.05	1	4.02	1
A73	May-13	9220	1	31.9	1	2.02	0	4.1	1	176	1	591	1	3320	1	6.07	1	0.717	1	2.78	1	998	1	0.036	1	5.6	1
A73	Apr-14	40700	1	33.8	1	4.2	1	5.6	1	284	1	297	1	7120	1	7.19	1	1.0	0	1.35	1	1450	1			2.83	1
A73	Sep-14	6770	1	20.5	1	2.04	0	2.7	1	113		435	1	2780	1	5.5	1	1.02	0	1.24	1	749	1	0.02	1	3.5	1
A73B	Oct-12	31900	1	39.4	1	3.24	1	4.24	1	292	1	468	1	2610	1	12.1	1	2.89	1	3.09	1	1720	1	0.09	1	5.02	1
A73B	May-13	10600	1	30.4	1	2	0	3.56	1	140	1	593	1	4340	1	9.78	1	0.5	0	1.65	1	964	1			4.72	1
A73B	Sep-14	6620	1	19.9	1	2.03	0	2.72	1	98.8	1	540	1	2480	1	8.16	1	1.01	0	1.25	1	659	1	0.04	1	3.68	1
A75B	Oct-12	48600	1	37.2	1	5.98	1	10.5	1	413	1	435	1	3820	1	16.5	1	3.26	1	2.18	1	5320	1	0.07	1	5.16	1
A75B	May-13	7220	1	13.3	1	1.99	0	2.65	1	82.7	1	354	1	2340	1	5.93	1	0.588	1	1.51	1	672	1			5.45	1
A75B	Sep-14	6640	1	9.22	1	1.99	0	1.99	1	67	1	98	1	2070	1	6.71	1	0.994	0	0.512	1	578	1	0.01	0	5.01	1
A75D	Oct-12	15600	1	13.2	1	1.97	0	4.87	1	152	1	231	1	3010	1	9.09	1	1.4	1	0.724	1	1930	1	0.04	1	3.73	1
A75D	May-13	8550	1	18.2	1	1.99	0	3.88	1	108	1	367	1	3730	1	7.27	1	0.498	0	1.37	1	1030	1	0.038	1	4.99	1
A75D	Apr-14	29900	1	28.5	1	3.66	1	6.75	1	223	1	261	1	6900	1	13.1	1	1.06	1	1.27	1	2910	1			4.39	1
A75D	Sep-14	7660	1	17.5	1	2.03	0	3.73	1	103	1	339	1	3750	1	8.2	1	1.02	0	0.948	1	1080	1	0.02	0	3.72	1
Bakers Bridge	Oct-12	37400	1	29.7	1	4.85	1	18.6	1	357	1	378	1	10500	1	31.6	1	3.1	1	1.71	1	8670	1	0.06	1	5.21	1
Bakers Bridge	May-13	7360	1	15.9	1	1.98	0	2.46	1	116	1	328	1	2130	1	7.36	1	0.496	0	1.08	1	2080	1			7.38	1
Bakers Bridge	Apr-14	27300	1	25.9	1	3.51	1	14.6	1	199	1	248	1	13100	1	22	1	1.16	1	1.33	1	6030	1	0.043	1	4.28	1
Bakers Bridge	Sep-14	8040	1	16.2	1	1.99	0	4.63	1	92	1	244	1	3970	1	12.1	1	0.997	0	1.02	1	1700	1	0.02	1	4.74	1

shaded = ND

ProUCL calculations for As in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 10:36
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	16.4	Mean	27.43
Maximum	89.5	Median	21.55
SD	16.51	Std. Error of Mean	3.692
Coefficient of Variation	0.602	Skewness	3.144
Normal GOF Test			
Shapiro Wilk Test Statistic	0.593	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.313	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	33.81	95% Adjusted-CLT UCL (Chen-1995)	36.27
		95% Modified-t UCL (Johnson-1978)	34.24
Gamma GOF Test			
A-D Test Statistic	1.88	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.259	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	5.168	k star (bias corrected MLE)	4.426
Theta hat (MLE)	5.307	Theta star (bias corrected MLE)	6.197
nu hat (MLE)	206.7	nu star (bias corrected)	177
MLE Mean (bias corrected)	27.43	MLE Sd (bias corrected)	13.04
		Approximate Chi Square Value (0.05)	147.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	145.1
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	32.97	95% Adjusted Gamma UCL (use when n<50)	33.46
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.79	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.797	Mean of logged Data	3.212
Maximum of Logged Data	4.494	SD of logged Data	0.405
Assuming Lognormal Distribution			
95% H-UCL	32.25	90% Chebyshev (MVUE) UCL	34.29
95% Chebyshev (MVUE) UCL	37.68	97.5% Chebyshev (MVUE) UCL	42.38
99% Chebyshev (MVUE) UCL	51.6		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	33.5	95% Jackknife UCL	33.81
95% Standard Bootstrap UCL	33.45	95% Bootstrap-t UCL	42.98
95% Hall's Bootstrap UCL	53.96	95% Percentile Bootstrap UCL	33.73
95% BCA Bootstrap UCL	37.12		
90% Chebyshev(Mean, Sd) UCL	38.5	95% Chebyshev(Mean, Sd) UCL	43.52
97.5% Chebyshev(Mean, Sd) UCL	50.48	99% Chebyshev(Mean, Sd) UCL	64.16
Suggested UCL to Use			
95% Student's-t UCL	33.81	or 95% Modified-t UCL	34.24

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Be in sediment of the Animas River above mainstem Cement Creek

User Selected Options			
Date/Time of Computation	2/18/2015 10:42		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
General Statistics			
Total Number of Observations	20	Number of Distinct Observations	14
Number of Detects	9	Number of Non-Detects	11
Number of Distinct Detects	9	Number of Distinct Non-Detects	5
Minimum Detect	2.1	Minimum Non-Detect	1.97
Maximum Detect	6.77	Maximum Non-Detect	2.03
Variance Detects	2.075	Percent Non-Detects	55%
Mean Detects	3.042	SD Detects	1.44
Median Detects	2.77	CV Detects	0.473
Skewness Detects	2.668	Kurtosis Detects	7.565
Mean of Logged Detects	1.045	SD of Logged Detects	0.353
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.616	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.401	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data Not Normal at 5% Significance Level	
Detected Data Not Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	2.453	Standard Error of Mean	0.25
SD	1.056	95% KM (BCA) UCL	2.95
95% KM (t) UCL	2.885	95% KM (Percentile Bootstrap) UCL	2.9
95% KM (z) UCL	2.864	95% KM Bootstrap t UCL	3.482
90% KM Chebyshev UCL	3.204	95% KM Chebyshev UCL	3.544
97.5% KM Chebyshev UCL	4.016	99% KM Chebyshev UCL	4.944
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	1.129	Anderson-Darling GOF Test	
5% A-D Critical Value	0.722	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.356	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.28	Detected Data Not Gamma Distributed at 5% Significance Level	
Detected Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	7.606	k star (bias corrected MLE)	5.145
Theta hat (MLE)	0.4	Theta star (bias corrected MLE)	0.591
nu hat (MLE)	136.9	nu star (bias corrected)	92.61
MLE Mean (bias corrected)	3.042	MLE Sd (bias corrected)	1.341
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	5.398	nu hat (KM)	215.9
Approximate Chi Square Value (215.90, α)	182.9	Adjusted Chi Square Value (215.90, β)	180.5
95% Gamma Approximate KM-UCL (use when n>=50)	2.895	95% Gamma Adjusted KM-UCL (use when n<50)	2.934
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	1.492
Maximum	6.77	Median	0.625
SD	1.727	CV	1.158
k hat (MLE)	0.43	k star (bias corrected MLE)	0.399
Theta hat (MLE)	3.466	Theta star (bias corrected MLE)	3.738
nu hat (MLE)	17.22	nu star (bias corrected)	15.97
MLE Mean (bias corrected)	1.492	MLE Sd (bias corrected)	2.361
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (15.97, α)	7.939	Adjusted Chi Square Value (15.97, β)	7.493
95% Gamma Approximate UCL (use when n>=50)	3.001	95% Gamma Adjusted UCL (use when n<50)	3.179
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.748	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.329	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.295	Detected Data Not Lognormal at 5% Significance Level	
Detected Data Not Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	1.979	Mean in Log Scale	0.515
SD in Original Scale	1.37	SD in Log Scale	0.566
95% t UCL (assumes normality of ROS data)	2.508	95% Percentile Bootstrap UCL	2.502
95% BCA Bootstrap UCL	2.657	95% Bootstrap t UCL	2.861
95% H-UCL (Log ROS)	2.575		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.921	Mean in Log Scale	0.473
SD in Original Scale	1.398	SD in Log Scale	0.579
95% t UCL (Assumes normality)	2.462	95% H-Stat UCL	2.507
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	2.885	95% KM (% Bootstrap) UCL	2.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River above mainstem Cement Creek

User Selected Options			
Date/Time of Computation	2/18/2015 10:50		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	4.95	Mean	11.12
Maximum	24.2	Median	10.25
SD	4.627	Std. Error of Mean	1.035
Coefficient of Variation	0.416	Skewness	1.254

Normal GOF Test			
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.135	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.91	95% Adjusted-CLT UCL (Chen-1995)	13.14
		95% Modified-t UCL (Johnson-1978)	12.96

Gamma GOF Test		
A-D Test Statistic	0.156	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0828	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	6.801	k star (bias corrected MLE)	5.814
Theta hat (MLE)	1.635	Theta star (bias corrected MLE)	1.913
nu hat (MLE)	272.1	nu star (bias corrected)	232.6
MLE Mean (bias corrected)	11.12	MLE Sd (bias corrected)	4.613
		Approximate Chi Square Value (0.05)	198.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	195.8

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	13.05	95% Adjusted Gamma UCL (use when n<50)	13.21

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.992	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.067	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	1.599	Mean of logged Data	2.334
Maximum of Logged Data	3.186	SD of logged Data	0.395

Assuming Lognormal Distribution			
95% H-UCL	13.28	90% Chebyshev (MVUE) UCL	14.12
95% Chebyshev (MVUE) UCL	15.49	97.5% Chebyshev (MVUE) UCL	17.39
99% Chebyshev (MVUE) UCL	21.11		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	12.83	95% Jackknife UCL	12.91
95% Standard Bootstrap UCL	12.84	95% Bootstrap-t UCL	13.35
95% Hall's Bootstrap UCL	13.78	95% Percentile Bootstrap UCL	12.89
95% BCA Bootstrap UCL	13.13		
90% Chebyshev(Mean, Sd) UCL	14.23	95% Chebyshev(Mean, Sd) UCL	15.63
97.5% Chebyshev(Mean, Sd) UCL	17.58	99% Chebyshev(Mean, Sd) UCL	21.42

Suggested UCL to Use

95% Student's-t UCL	12.91

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River above mainstem Cement Creek

User Selected Options			
Date/Time of Computation	2/18/2015 10:56		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

Cu

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	166	Mean	339.4
Maximum	745	Median	307
SD	141.1	Std. Error of Mean	31.56
Coefficient of Variation	0.416	Skewness	1.722

Normal GOF Test

Shapiro Wilk Test Statistic	0.832	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.21	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	394	95% Adjusted-CLT UCL (Chen-1995)	404.3
		95% Modified-t UCL (Johnson-1978)	396

Gamma GOF Test

A-D Test Statistic	0.578	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	7.596	k star (bias corrected MLE)	6.49
Theta hat (MLE)	44.68	Theta star (bias corrected MLE)	52.3
nu hat (MLE)	303.8	nu star (bias corrected)	259.6
MLE Mean (bias corrected)	339.4	MLE Sd (bias corrected)	133.2
		Approximate Chi Square Value (0.05)	223.3
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	220.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	394.6	95% Adjusted Gamma UCL (use when n<50)	399.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.135	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	5.112	Mean of logged Data	5.76
Maximum of Logged Data	6.613	SD of logged Data	0.363

Assuming Lognormal Distribution

95% H-UCL	396.9	90% Chebyshev (MVUE) UCL	421.5
95% Chebyshev (MVUE) UCL	459.5	97.5% Chebyshev (MVUE) UCL	512.2
99% Chebyshev (MVUE) UCL	615.7		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	391.3	95% Jackknife UCL	394
95% Standard Bootstrap UCL	389.5	95% Bootstrap-t UCL	422
95% Hall's Bootstrap UCL	516.4	95% Percentile Bootstrap UCL	392.5
95% BCA Bootstrap UCL	398.8		
90% Chebyshev(Mean, Sd) UCL	434.1	95% Chebyshev(Mean, Sd) UCL	477
97.5% Chebyshev(Mean, Sd) UCL	536.5	99% Chebyshev(Mean, Sd) UCL	653.4

Suggested UCL to Use

95% Adjusted Gamma UCL	399.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/23/2015 8:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	3.55	Mean	4.651
Maximum	6.35	Median	4.735
SD	0.827	Std. Error of Mean	0.185
Coefficient of Variation	0.178	Skewness	0.261
Normal GOF Test			
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.124	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.971	95% Adjusted-CLT UCL (Chen-1995)	4.967
		95% Modified-t UCL (Johnson-1978)	4.973
Gamma GOF Test			
A-D Test Statistic	0.422	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.131	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	33.44	k star (bias corrected MLE)	28.45
Theta hat (MLE)	0.139	Theta star (bias corrected MLE)	0.163
nu hat (MLE)	1337	nu star (bias corrected)	1138
MLE Mean (bias corrected)	4.651	MLE Sd (bias corrected)	0.872
		Approximate Chi Square Value (0.05)	1061
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	1055
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	4.99	95% Adjusted Gamma UCL (use when n<50)	5.018
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.125	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.267	Mean of logged Data	1.522
Maximum of Logged Data	1.848	SD of logged Data	0.178
Assuming Lognormal Distribution			
95% H-UCL	5.004	90% Chebyshev (MVUE) UCL	5.209
95% Chebyshev (MVUE) UCL	5.462	97.5% Chebyshev (MVUE) UCL	5.813
99% Chebyshev (MVUE) UCL	6.503		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.955	95% Jackknife UCL	4.971
95% Standard Bootstrap UCL	4.944	95% Bootstrap-t UCL	4.983
95% Hall's Bootstrap UCL	4.967	95% Percentile Bootstrap UCL	4.941
95% BCA Bootstrap UCL	4.984		
90% Chebyshev(Mean, Sd) UCL	5.206	95% Chebyshev(Mean, Sd) UCL	5.457
97.5% Chebyshev(Mean, Sd) UCL	5.806	99% Chebyshev(Mean, Sd) UCL	6.491
Suggested UCL to Use			
95% Student's-t UCL	4.971		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:01
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	0.02	Mean	0.0705
Maximum	0.19	Median	0.058
SD	0.0442	Std. Error of Mean	0.0118
Coefficient of Variation	0.627	Skewness	1.715
Normal GOF Test			
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.192	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0914	95% Adjusted-CLT UCL (Chen-1995)	0.0957
		95% Modified-t UCL (Johnson-1978)	0.0923
Gamma GOF Test			
A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.129	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3.322	k star (bias corrected MLE)	2.657
Theta hat (MLE)	0.0212	Theta star (bias corrected MLE)	0.0265
nu hat (MLE)	93	nu star (bias corrected)	74.41
MLE Mean (bias corrected)	0.0705	MLE Sd (bias corrected)	0.0432
		Approximate Chi Square Value (0.05)	55.54
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	53.38
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0.0944	95% Adjusted Gamma UCL (use when n<50)	0.0983
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.237	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-3.912	Mean of logged Data	-2.81
Maximum of Logged Data	-1.661	SD of logged Data	0.581
Assuming Lognormal Distribution			
95% H-UCL	0.101	90% Chebyshev (MVUE) UCL	0.104
95% Chebyshev (MVUE) UCL	0.12	97.5% Chebyshev (MVUE) UCL	0.141
99% Chebyshev (MVUE) UCL	0.183		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0.0899	95% Jackknife UCL	0.0914
95% Standard Bootstrap UCL	0.0891	95% Bootstrap-t UCL	0.106
95% Hall's Bootstrap UCL	0.204	95% Percentile Bootstrap UCL	0.0911
95% BCA Bootstrap UCL	0.0951		
90% Chebyshev(Mean, Sd) UCL	0.106	95% Chebyshev(Mean, Sd) UCL	0.122
97.5% Chebyshev(Mean, Sd) UCL	0.144	99% Chebyshev(Mean, Sd) UCL	0.188
Suggested UCL to Use			
95% Student's-t UCL	0.0914		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 10:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	554	Mean	1508
Maximum	3030	Median	1320
SD	582	Std. Error of Mean	130.1
Coefficient of Variation	0.386	Skewness	0.809
Normal GOF Test			
Shapiro Wilk Test Statistic	0.944	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.178	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1733	95% Adjusted-CLT UCL (Chen-1995)	1747
		95% Modified-t UCL (Johnson-1978)	1737
Gamma GOF Test			
A-D Test Statistic	0.281	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.149	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.178	k star (bias corrected MLE)	6.134
Theta hat (MLE)	210.1	Theta star (bias corrected MLE)	245.9
nu hat (MLE)	287.1	nu star (bias corrected)	245.4
MLE Mean (bias corrected)	1508	MLE Sd (bias corrected)	609
		Approximate Chi Square Value (0.05)	210.1
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	207.5
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1761	95% Adjusted Gamma UCL (use when n<50)	1783
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.124	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.317	Mean of logged Data	7.247
Maximum of Logged Data	8.016	SD of logged Data	0.394
Assuming Lognormal Distribution			
95% H-UCL	1807	90% Chebyshev (MVUE) UCL	1921
95% Chebyshev (MVUE) UCL	2106	97.5% Chebyshev (MVUE) UCL	2364
99% Chebyshev (MVUE) UCL	2869		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1722	95% Jackknife UCL	1733
95% Standard Bootstrap UCL	1718	95% Bootstrap-t UCL	1766
95% Hall's Bootstrap UCL	1765	95% Percentile Bootstrap UCL	1711
95% BCA Bootstrap UCL	1744		
90% Chebyshev(Mean, Sd) UCL	1899	95% Chebyshev(Mean, Sd) UCL	2076
97.5% Chebyshev(Mean, Sd) UCL	2321	99% Chebyshev(Mean, Sd) UCL	2803
Suggested UCL to Use			
95% Student's-t UCL	1733		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:00
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	3400	Mean	10617
Maximum	22300	Median	9550
SD	5041	Std. Error of Mean	1127
Coefficient of Variation	0.475	Skewness	1.162
Normal GOF Test			
Shapiro Wilk Test Statistic	0.879	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.175	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12566	95% Adjusted-CLT UCL (Chen-1995)	12784
		95% Modified-t UCL (Johnson-1978)	12615
Gamma GOF Test			
A-D Test Statistic	0.449	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.124	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	5.159	k star (bias corrected MLE)	4.418
Theta hat (MLE)	2058	Theta star (bias corrected MLE)	2403
nu hat (MLE)	206.3	nu star (bias corrected)	176.7
MLE Mean (bias corrected)	10617	MLE Sd (bias corrected)	5051
		Approximate Chi Square Value (0.05)	147
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	144.8
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	12766	95% Adjusted Gamma UCL (use when n<50)	12954
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.111	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.132	Mean of logged Data	9.17
Maximum of Logged Data	10.01	SD of logged Data	0.461
Assuming Lognormal Distribution			
95% H-UCL	13172	90% Chebyshev (MVUE) UCL	14006
95% Chebyshev (MVUE) UCL	15540	97.5% Chebyshev (MVUE) UCL	17668
99% Chebyshev (MVUE) UCL	21850		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	12471	95% Jackknife UCL	12566
95% Standard Bootstrap UCL	12438	95% Bootstrap-t UCL	13047
95% Hall's Bootstrap UCL	12981	95% Percentile Bootstrap UCL	12460
95% BCA Bootstrap UCL	12792		
90% Chebyshev(Mean, Sd) UCL	13999	95% Chebyshev(Mean, Sd) UCL	15530
97.5% Chebyshev(Mean, Sd) UCL	17657	99% Chebyshev(Mean, Sd) UCL	21833
Suggested UCL to Use			
95% Student's-t UCL	12566		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/23/2015 8:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	5.92	Mean	8.224
Maximum	16.5	Median	7.32
SD	2.39	Std. Error of Mean	0.534
Coefficient of Variation	0.291	Skewness	2.335
Normal GOF Test			
Shapiro Wilk Test Statistic	0.758	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.206	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	9.148	95% Adjusted-CLT UCL (Chen-1995)	9.401
		95% Modified-t UCL (Johnson-1978)	9.195
Gamma GOF Test			
A-D Test Statistic	0.919	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.741	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.195	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.13	k star (bias corrected MLE)	13.74
Theta hat (MLE)	0.51	Theta star (bias corrected MLE)	0.599
nu hat (MLE)	645	nu star (bias corrected)	549.6
MLE Mean (bias corrected)	8.224	MLE Sd (bias corrected)	2.219
		Approximate Chi Square Value (0.05)	496.2
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	492.2
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	9.109	95% Adjusted Gamma UCL (use when n<50)	9.183
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.872	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.182	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.778	Mean of logged Data	2.076
Maximum of Logged Data	2.803	SD of logged Data	0.243
Assuming Lognormal Distribution			
95% H-UCL	9.084	90% Chebyshev (MVUE) UCL	9.547
95% Chebyshev (MVUE) UCL	10.16	97.5% Chebyshev (MVUE) UCL	11.01
99% Chebyshev (MVUE) UCL	12.67		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	9.103	95% Jackknife UCL	9.148
95% Standard Bootstrap UCL	9.073	95% Bootstrap-t UCL	9.687
95% Hall's Bootstrap UCL	12.83	95% Percentile Bootstrap UCL	9.099
95% BCA Bootstrap UCL	9.488		
90% Chebyshev(Mean, Sd) UCL	9.827	95% Chebyshev(Mean, Sd) UCL	10.55
97.5% Chebyshev(Mean, Sd) UCL	11.56	99% Chebyshev(Mean, Sd) UCL	13.54
Suggested UCL to Use			
95% Student's-t UCL	9.148	or 95% Modified-t UCL	9.195

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River above mainstem Cement Creek

User Selected Options			
Date/Time of Computation	2/18/2015 11:02		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operation:	2000		
General Statistics			
Total Number of Observations	20	Number of Distinct Observations	16
Number of Detects	4	Number of Non-Detects	16
Number of Distinct Detects	4	Number of Distinct Non-Detects	12
Minimum Detect	0.905	Minimum Non-Detect	0.497
Maximum Detect	2.86	Maximum Non-Detect	1.02
Variance Detects	0.801	Percent Non-Detects	80%
Mean Detects	1.539	SD Detects	0.895
Median Detects	1.195	CV Detects	0.581
Skewness Detects	1.817	Kurtosis Detects	3.401
Mean of Logged Detects	0.325	SD of Logged Detects	0.505
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.788	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.359	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level	
Detected Data appear Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	0.743	Standard Error of Mean	0.148
SD	0.54	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.998	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.986	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.186	95% KM Chebyshev UCL	1.387
97.5% KM Chebyshev UCL	1.666	99% KM Chebyshev UCL	2.214
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.486	Anderson-Darling GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.339	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	4.889	k star (bias corrected MLE)	1.389
Theta hat (MLE)	0.315	Theta star (bias corrected MLE)	1.108
nu hat (MLE)	39.12	nu star (bias corrected)	11.11
MLE Mean (bias corrected)	1.539	MLE Sd (bias corrected)	1.306
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	1.889	nu hat (KM)	75.57
Approximate Chi Square Value (75.57, α)	56.55	Adjusted Chi Square Value (75.57, β)	55.25
95% Gamma Approximate KM-UCL (use when n>=50	0.993	95% Gamma Adjusted KM-UCL (use when n<50)	1.016
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detected data is small such as < 0.1			
For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	0.321
Maximum	2.86	Median	0.01
SD	0.719	CV	2.241
k hat (MLE)	0.293	k star (bias corrected MLE)	0.283
Theta hat (MLE)	1.095	Theta star (bias corrected MLE)	1.136
nu hat (MLE)	11.73	nu star (bias corrected)	11.3
MLE Mean (bias corrected)	0.321	MLE Sd (bias corrected)	0.604
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (11.30, α)	4.77	Adjusted Chi Square Value (11.30, β)	4.438
95% Gamma Approximate UCL (use when n>=50)	0.76	95% Gamma Adjusted UCL (use when n<50)	N/A
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.873	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.306	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	0.525	Mean in Log Scale	-1.024
SD in Original Scale	0.636	SD in Log Scale	0.782
95% t UCL (assumes normality of ROS data)	0.771	95% Percentile Bootstrap UCL	0.78
95% BCA Bootstrap UCL	0.859	95% Bootstrap t UCL	1.086
95% H-UCL (Log ROS)	0.741		
UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed			
KM Mean (logged)	-0.439	95% H-UCL (KM -Log)	0.885
KM SD (logged)	0.462	95% Critical H Value (KM-Log)	1.983
KM Standard Error of Mean (logged)	0.139		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.646	Mean in Log Scale	-0.66
SD in Original Scale	0.589	SD in Log Scale	0.619
95% t UCL (Assumes normality)	0.874	95% H-Stat UCL	0.848
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	0.998	95% KM (Percentile Bootstrap) UCL	N/A
Warning: One or more Recommended UCL(s) not available!			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:03
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	2.9	Mean	5.491
Maximum	13.3	Median	4.845
SD	2.429	Std. Error of Mean	0.543
Coefficient of Variation	0.442	Skewness	2
Normal GOF Test			
Shapiro Wilk Test Statistic	0.805	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.194	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.43	95% Adjusted-CLT UCL (Chen-1995)	6.644
		95% Modified-t UCL (Johnson-1978)	6.471
Gamma GOF Test			
A-D Test Statistic	0.642	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.151	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.105	k star (bias corrected MLE)	6.072
Theta hat (MLE)	0.773	Theta star (bias corrected MLE)	0.904
nu hat (MLE)	284.2	nu star (bias corrected)	242.9
MLE Mean (bias corrected)	5.491	MLE Sd (bias corrected)	2.228
		Approximate Chi Square Value (0.05)	207.8
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	205.3
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.418	95% Adjusted Gamma UCL (use when n<50)	6.498
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.125	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.065	Mean of logged Data	1.631
Maximum of Logged Data	2.588	SD of logged Data	0.37
Assuming Lognormal Distribution			
95% H-UCL	6.43	90% Chebyshev (MVUE) UCL	6.831
95% Chebyshev (MVUE) UCL	7.457	97.5% Chebyshev (MVUE) UCL	8.324
99% Chebyshev (MVUE) UCL	10.03		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	6.384	95% Jackknife UCL	6.43
95% Standard Bootstrap UCL	6.373	95% Bootstrap-t UCL	6.957
95% Hall's Bootstrap UCL	9.672	95% Percentile Bootstrap UCL	6.436
95% BCA Bootstrap UCL	6.694		
90% Chebyshev(Mean, Sd) UCL	7.121	95% Chebyshev(Mean, Sd) UCL	7.859
97.5% Chebyshev(Mean, Sd) UCL	8.883	99% Chebyshev(Mean, Sd) UCL	10.9
Suggested UCL to Use			
95% Student's-t UCL	6.43		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River above mainstem Cement Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:04
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	1530	Mean	3172
Maximum	11500	Median	2660
SD	2124	Std. Error of Mean	474.9
Coefficient of Variation	0.67	Skewness	3.481
Normal GOF Test			
Shapiro Wilk Test Statistic	0.577	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.298	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3993	95% Adjusted-CLT UCL (Chen-1995)	4348
		95% Modified-t UCL (Johnson-1978)	4054
Gamma GOF Test			
A-D Test Statistic	1.438	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.235	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.195	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.47	k star (bias corrected MLE)	3.833
Theta hat (MLE)	709.6	Theta star (bias corrected MLE)	827.5
nu hat (MLE)	178.8	nu star (bias corrected)	153.3
MLE Mean (bias corrected)	3172	MLE Sd (bias corrected)	1620
		Approximate Chi Square Value (0.05)	125.7
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	123.7
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3868	95% Adjusted Gamma UCL (use when n<50)	3930
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.854	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.193	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.333	Mean of logged Data	7.946
Maximum of Logged Data	9.35	SD of logged Data	0.436
Assuming Lognormal Distribution			
95% H-UCL	3777	90% Chebyshev (MVUE) UCL	4017
95% Chebyshev (MVUE) UCL	4438	97.5% Chebyshev (MVUE) UCL	5021
99% Chebyshev (MVUE) UCL	6168		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	3953	95% Jackknife UCL	3993
95% Standard Bootstrap UCL	3935	95% Bootstrap-t UCL	5347
95% Hall's Bootstrap UCL	7080	95% Percentile Bootstrap UCL	4031
95% BCA Bootstrap UCL	4441		
90% Chebyshev(Mean, Sd) UCL	4596	95% Chebyshev(Mean, Sd) UCL	5242
97.5% Chebyshev(Mean, Sd) UCL	6137	99% Chebyshev(Mean, Sd) UCL	7897
Suggested UCL to Use			
95% Student's-t UCL	3993	or 95% Modified-t UCL	4054

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:37
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	9960	Mean	14872
Maximum	21500	Median	12200
SD	5021	Std. Error of Mean	2246
Coefficient of Variation	0.338	Skewness	0.625

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.303	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19659	95% Adjusted-CLT UCL (Chen-1995)	19237
		95% Modified-t UCL (Johnson-1978)	19764

Gamma GOF Test

A-D Test Statistic	0.437	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.308	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.42	k star (bias corrected MLE)	4.702
Theta hat (MLE)	1302	Theta star (bias corrected MLE)	3163
nu hat (MLE)	114.2	nu star (bias corrected)	47.02
MLE Mean (bias corrected)	14872	MLE Sd (bias corrected)	6858
		Approximate Chi Square Value (0.05)	32.28
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	27.06

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21660	95% Adjusted Gamma UCL (use when n<50)	25846

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.279	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.206	Mean of logged Data	9.563
Maximum of Logged Data	9.976	SD of logged Data	0.33

Assuming Lognormal Distribution

95% H-UCL	22609	90% Chebyshev (MVUE) UCL	21419
95% Chebyshev (MVUE) UCL	24392	97.5% Chebyshev (MVUE) UCL	28518
99% Chebyshev (MVUE) UCL	36622		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	18566	95% Jackknife UCL	19659
95% Standard Bootstrap UCL	18189	95% Bootstrap-t UCL	31997
95% Hall's Bootstrap UCL	72144	95% Percentile Bootstrap UCL	18520
95% BCA Bootstrap UCL	18520		
90% Chebyshev(Mean, Sd) UCL	21609	95% Chebyshev(Mean, Sd) UCL	24661
97.5% Chebyshev(Mean, Sd) UCL	28896	99% Chebyshev(Mean, Sd) UCL	37216

Suggested UCL to Use

95% Student's-t UCL	19659

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:39
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	26.1	Mean	33.36
Maximum	40.6	Median	36.3
SD	6.52	Std. Error of Mean	2.916
Coefficient of Variation	0.195	Skewness	-0.318

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.861	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.274	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	39.58	95% Adjusted-CLT UCL (Chen-1995)	37.71
		95% Modified-t UCL (Johnson-1978)	39.51

Gamma GOF Test

A-D Test Statistic	0.522	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.305	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	31.44	k star (bias corrected MLE)	12.71
Theta hat (MLE)	1.061	Theta star (bias corrected MLE)	2.625
nu hat (MLE)	314.4	nu star (bias corrected)	127.1
MLE Mean (bias corrected)	33.36	MLE Sd (bias corrected)	9.358
		Approximate Chi Square Value (0.05)	102
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	92.23

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	41.55	95% Adjusted Gamma UCL (use when n<50)	45.96

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.845	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.29	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.262	Mean of logged Data	3.491
Maximum of Logged Data	3.704	SD of logged Data	0.202

Assuming Lognormal Distribution

95% H-UCL	41.86	90% Chebyshev (MVUE) UCL	42.4
95% Chebyshev (MVUE) UCL	46.5	97.5% Chebyshev (MVUE) UCL	52.18
99% Chebyshev (MVUE) UCL	63.33		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	38.16	95% Jackknife UCL	39.58
95% Standard Bootstrap UCL	37.76	95% Bootstrap-t UCL	39.89
95% Hall's Bootstrap UCL	36.05	95% Percentile Bootstrap UCL	37.58
95% BCA Bootstrap UCL	37.12		
90% Chebyshev(Mean, Sd) UCL	42.11	95% Chebyshev(Mean, Sd) UCL	46.07
97.5% Chebyshev(Mean, Sd) UCL	51.57	99% Chebyshev(Mean, Sd) UCL	62.37

Suggested UCL to Use

95% Student's-t UCL	39.58

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	2/18/2015 11:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.15	Mean	2.098
Maximum	3.03	Median	1.81
SD	0.791	Std. Error of Mean	0.354
Coefficient of Variation	0.377	Skewness	0.182

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.242	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.852	95% Adjusted-CLT UCL (Chen-1995)	2.711
		95% Modified-t UCL (Johnson-1978)	2.857

Gamma GOF Test

A-D Test Statistic	0.321	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.239	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.413	k star (bias corrected MLE)	3.499
Theta hat (MLE)	0.249	Theta star (bias corrected MLE)	0.6
nu hat (MLE)	84.13	nu star (bias corrected)	34.99
MLE Mean (bias corrected)	2.098	MLE Sd (bias corrected)	1.122
		Approximate Chi Square Value (0.05)	22.45
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	18.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.269	95% Adjusted Gamma UCL (use when n<50)	4.034

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.931	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.211	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.14	Mean of logged Data	0.68
Maximum of Logged Data	1.109	SD of logged Data	0.396

Assuming Lognormal Distribution

95% H-UCL	3.603	90% Chebyshev (MVUE) UCL	3.212
95% Chebyshev (MVUE) UCL	3.715	97.5% Chebyshev (MVUE) UCL	4.413
99% Chebyshev (MVUE) UCL	5.784		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.68	95% Jackknife UCL	2.852
95% Standard Bootstrap UCL	2.626	95% Bootstrap-t UCL	3.551
95% Hall's Bootstrap UCL	4.181	95% Percentile Bootstrap UCL	2.626
95% BCA Bootstrap UCL	2.602		
90% Chebyshev(Mean, Sd) UCL	3.159	95% Chebyshev(Mean, Sd) UCL	3.64
97.5% Chebyshev(Mean, Sd) UCL	4.307	99% Chebyshev(Mean, Sd) UCL	5.617

Suggested UCL to Use

95% Student's-t UCL	2.852

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:47
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	77.8	Mean	137.4
Maximum	179	Median	145
SD	37.33	Std. Error of Mean	16.69
Coefficient of Variation	0.272	Skewness	-1.086

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.254	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	172.9	95% Adjusted-CLT UCL (Chen-1995)	156.2
		95% Modified-t UCL (Johnson-1978)	171.6
Gamma GOF Test			
A-D Test Statistic	0.437	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.01	k star (bias corrected MLE)	5.738
Theta hat (MLE)	9.803	Theta star (bias corrected MLE)	23.94
nu hat (MLE)	140.1	nu star (bias corrected)	57.38
MLE Mean (bias corrected)	137.4	MLE Sd (bias corrected)	57.34
		Approximate Chi Square Value (0.05)	40.97
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	35
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	192.4	95% Adjusted Gamma UCL (use when n<50)	225.2
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.856	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.305	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.354	Mean of logged Data	4.886
Maximum of Logged Data	5.187	SD of logged Data	0.317
Assuming Lognormal Distribution			
95% H-UCL	205	90% Chebyshev (MVUE) UCL	196.2
95% Chebyshev (MVUE) UCL	222.7	97.5% Chebyshev (MVUE) UCL	259.4
99% Chebyshev (MVUE) UCL	331.4		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	164.8	95% Jackknife UCL	172.9
95% Standard Bootstrap UCL	162	95% Bootstrap-t UCL	160.5
95% Hall's Bootstrap UCL	156.7	95% Percentile Bootstrap UCL	160
95% BCA Bootstrap UCL	153.8		
90% Chebyshev(Mean, Sd) UCL	187.4	95% Chebyshev(Mean, Sd) UCL	210.1
97.5% Chebyshev(Mean, Sd) UCL	241.6	99% Chebyshev(Mean, Sd) UCL	303.5

Suggested UCL to Use

95% Student's-t UCL	172.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	3.01	Mean	4.604
Maximum	6.41	Median	4.05
SD	1.556	Std. Error of Mean	0.696
Coefficient of Variation	0.338	Skewness	0.385

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.868	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.239	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.087	95% Adjusted-CLT UCL (Chen-1995)	5.876
		95% Modified-t UCL (Johnson-1978)	6.107
Gamma GOF Test			
A-D Test Statistic	0.411	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	11.06	k star (bias corrected MLE)	4.557
Theta hat (MLE)	0.416	Theta star (bias corrected MLE)	1.01
nu hat (MLE)	110.6	nu star (bias corrected)	45.57
MLE Mean (bias corrected)	4.604	MLE Sd (bias corrected)	2.157
		Approximate Chi Square Value (0.05)	31.09
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	25.97
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.75	95% Adjusted Gamma UCL (use when n<50)	8.08
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.102	Mean of logged Data	1.481
Maximum of Logged Data	1.858	SD of logged Data	0.339
Assuming Lognormal Distribution			
95% H-UCL	7.101	90% Chebyshev (MVUE) UCL	6.684
95% Chebyshev (MVUE) UCL	7.627	97.5% Chebyshev (MVUE) UCL	8.936
99% Chebyshev (MVUE) UCL	11.51		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.748	95% Jackknife UCL	6.087
95% Standard Bootstrap UCL	5.617	95% Bootstrap-t UCL	8.093
95% Hall's Bootstrap UCL	7.589	95% Percentile Bootstrap UCL	5.73
95% BCA Bootstrap UCL	5.694		
90% Chebyshev(Mean, Sd) UCL	6.691	95% Chebyshev(Mean, Sd) UCL	7.636
97.5% Chebyshev(Mean, Sd) UCL	8.948	99% Chebyshev(Mean, Sd) UCL	11.53

Suggested UCL to Use

95% Student's-t UCL	6.087

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/23/2015 9:09		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.039	Mean	0.0553
Maximum	0.072	Median	0.055
SD	0.0141	Std. Error of Mean	0.00704
Coefficient of Variation	0.255	Skewness	0.0886

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.997	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0718	95% Adjusted-CLT UCL (Chen-1995)	0.0672
		95% Modified-t UCL (Johnson-1978)	0.0719
Gamma GOF Test			
A-D Test Statistic	0.197	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.173	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	19.99	k star (bias corrected MLE)	5.164
Theta hat (MLE)	0.00276	Theta star (bias corrected MLE)	0.0107
nu hat (MLE)	159.9	nu star (bias corrected)	41.32
MLE Mean (bias corrected)	0.0553	MLE Sd (bias corrected)	0.0243
		Approximate Chi Square Value (0.05)	27.58
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0.0828	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.993	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-3.244	Mean of logged Data	-2.921
Maximum of Logged Data	-2.631	SD of logged Data	0.262
Assuming Lognormal Distribution			
95% H-UCL	0.0832	90% Chebyshev (MVUE) UCL	0.0769
95% Chebyshev (MVUE) UCL	0.0866	97.5% Chebyshev (MVUE) UCL	0.1
99% Chebyshev (MVUE) UCL	0.127		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0.0668	95% Jackknife UCL	0.0718
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0764	95% Chebyshev(Mean, Sd) UCL	0.0859
97.5% Chebyshev(Mean, Sd) UCL	0.0992	99% Chebyshev(Mean, Sd) UCL	0.125

Suggested UCL to Use

95% Student's-t UCL	0.0718

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:49
From File	WorkSheet.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	299	Mean	478.2
Maximum	581	Median	499
SD	108.7	Std. Error of Mean	48.61
Coefficient of Variation	0.227	Skewness	-1.428

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.888	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.27	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	581.8	95% Adjusted-CLT UCL (Chen-1995)	525
		95% Modified-t UCL (Johnson-1978)	576.6

Gamma GOF Test

A-D Test Statistic	0.487	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.299	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	20.27	k star (bias corrected MLE)	8.242
Theta hat (MLE)	23.59	Theta star (bias corrected MLE)	58.02
nu hat (MLE)	202.7	nu star (bias corrected)	82.42
MLE Mean (bias corrected)	478.2	MLE Sd (bias corrected)	166.6
		Approximate Chi Square Value (0.05)	62.49
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	54.97

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	630.6	95% Adjusted Gamma UCL (use when n<50)	717

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.312	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.7	Mean of logged Data	6.145
Maximum of Logged Data	6.365	SD of logged Data	0.261

Assuming Lognormal Distribution

95% H-UCL	653.4	90% Chebyshev (MVUE) UCL	647
95% Chebyshev (MVUE) UCL	722.9	97.5% Chebyshev (MVUE) UCL	828.3
99% Chebyshev (MVUE) UCL	1035		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	558.1	95% Jackknife UCL	581.8
95% Standard Bootstrap UCL	548.5	95% Bootstrap-t UCL	555.4
95% Hall's Bootstrap UCL	529.1	95% Percentile Bootstrap UCL	541.2
95% BCA Bootstrap UCL	531.8		
90% Chebyshev(Mean, Sd) UCL	624	95% Chebyshev(Mean, Sd) UCL	690.1
97.5% Chebyshev(Mean, Sd) UCL	781.7	99% Chebyshev(Mean, Sd) UCL	961.8

Suggested UCL to Use

95% Student's-t UCL	581.8

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:50
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1210	Mean	2100
Maximum	3400	Median	1710
SD	922.4	Std. Error of Mean	412.5
Coefficient of Variation	0.439	Skewness	0.748

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.905	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.264	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2979	95% Adjusted-CLT UCL (Chen-1995)	2926
		95% Modified-t UCL (Johnson-1978)	3002

Gamma GOF Test

A-D Test Statistic	0.32	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.251	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	6.801	k star (bias corrected MLE)	2.854
Theta hat (MLE)	308.8	Theta star (bias corrected MLE)	735.9
nu hat (MLE)	68.01	nu star (bias corrected)	28.54
MLE Mean (bias corrected)	2100	MLE Sd (bias corrected)	1243
		Approximate Chi Square Value (0.05)	17.35
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	13.68

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3455	95% Adjusted Gamma UCL (use when n<50)	4381

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.219	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	7.098	Mean of logged Data	7.574
Maximum of Logged Data	8.132	SD of logged Data	0.431

Assuming Lognormal Distribution

95% H-UCL	3853	90% Chebyshev (MVUE) UCL	3299
95% Chebyshev (MVUE) UCL	3844	97.5% Chebyshev (MVUE) UCL	4601
99% Chebyshev (MVUE) UCL	6087		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2779	95% Jackknife UCL	2979
95% Standard Bootstrap UCL	2696	95% Bootstrap-t UCL	4698
95% Hall's Bootstrap UCL	9488	95% Percentile Bootstrap UCL	2724
95% BCA Bootstrap UCL	2738		
90% Chebyshev(Mean, Sd) UCL	3338	95% Chebyshev(Mean, Sd) UCL	3898
97.5% Chebyshev(Mean, Sd) UCL	4676	99% Chebyshev(Mean, Sd) UCL	6204

Suggested UCL to Use

95% Student's-t UCL	2979

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:52
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	4.33	Mean	5.142
Maximum	6.38	Median	4.88
SD	0.778	Std. Error of Mean	0.348
Coefficient of Variation	0.151	Skewness	1.157

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.921	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.232	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.884	95% Adjusted-CLT UCL (Chen-1995)	5.907
		95% Modified-t UCL (Johnson-1978)	5.914

Gamma GOF Test

A-D Test Statistic	0.3	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.237	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	57.71	k star (bias corrected MLE)	23.22
Theta hat (MLE)	0.0891	Theta star (bias corrected MLE)	0.221
nu hat (MLE)	577.1	nu star (bias corrected)	232.2
MLE Mean (bias corrected)	5.142	MLE Sd (bias corrected)	1.067
		Approximate Chi Square Value (0.05)	197.9
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	184

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.032	95% Adjusted Gamma UCL (use when n<50)	6.489

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.218	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.466	Mean of logged Data	1.629
Maximum of Logged Data	1.853	SD of logged Data	0.146

Assuming Lognormal Distribution

95% H-UCL	6.004	90% Chebyshev (MVUE) UCL	6.144
95% Chebyshev (MVUE) UCL	6.599	97.5% Chebyshev (MVUE) UCL	7.229
99% Chebyshev (MVUE) UCL	8.468		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.714	95% Jackknife UCL	5.884
95% Standard Bootstrap UCL	5.643	95% Bootstrap-t UCL	6.52
95% Hall's Bootstrap UCL	9.599	95% Percentile Bootstrap UCL	5.67
95% BCA Bootstrap UCL	5.78		
90% Chebyshev(Mean, Sd) UCL	6.186	95% Chebyshev(Mean, Sd) UCL	6.658
97.5% Chebyshev(Mean, Sd) UCL	7.314	99% Chebyshev(Mean, Sd) UCL	8.603

Suggested UCL to Use

95% Student's-t UCL	5.884

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:53
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	1.04	Minimum Non-Detect	1.02
Maximum Detect	2.03	Maximum Non-Detect	1.02
Variance Detects	0.268	Percent Non-Detects	20%
Mean Detects	1.488	SD Detects	0.517
Median Detects	1.44	CV Detects	0.348
Skewness Detects	0.127	Kurtosis Detects	-5.265
Mean of Logged Detects	0.35	SD of Logged Detects	0.356

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.819	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.301	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.394	Standard Error of Mean	0.228
SD	0.442	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.881	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.77	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	2.079	95% KM Chebyshev UCL	2.39
97.5% KM Chebyshev UCL	2.82	99% KM Chebyshev UCL	3.667

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.56	Anderson-Darling GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.336	Kolmogrov-SmirnoffGOF
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.8	k star (bias corrected MLE)	2.867
Theta hat (MLE)	0.138	Theta star (bias corrected MLE)	0.519
nu hat (MLE)	86.41	nu star (bias corrected)	22.94
MLE Mean (bias corrected)	1.488	MLE Sd (bias corrected)	0.879

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	9.934	nu hat (KM)	99.34
Approximate Chi Square Value (99.34, α)	77.34	Adjusted Chi Square Value (99.34, β)	68.89
95% Gamma Approximate KM-UCL (use when n>=50)	1.79	95% Gamma Adjusted KM-UCL (use when n<50)	2.01

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.364	Mean	1.263
Maximum	2.03	Median	1.05
SD	0.673	CV	0.533
k hat (MLE)	3.378	k star (bias corrected MLE)	1.485
Theta hat (MLE)	0.374	Theta star (bias corrected MLE)	0.851
nu hat (MLE)	33.78	nu star (bias corrected)	14.85
MLE Mean (bias corrected)	1.263	MLE Sd (bias corrected)	1.036
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (14.85, α)	7.154	Adjusted Chi Square Value (14.85, β)	4.997
95% Gamma Approximate UCL (use when n>=50)	2.621	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.804	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.301	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.306	Mean in Log Scale	0.172
SD in Original Scale	0.604	SD in Log Scale	0.504
95% t UCL (assumes normality of ROS data)	1.882	95% Percentile Bootstrap UCL	1.714
95% BCA Bootstrap UCL	1.66	95% Bootstrap t UCL	2.339
95% H-UCL (Log ROS)	2.842		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.284	95% H-UCL (KM -Log)	2.014
KM SD (logged)	0.306	95% Critical H Value (KM-Log)	2.415
KM Standard Error of Mean (logged)	0.158		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.292	Mean in Log Scale	0.145
SD in Original Scale	0.626	SD in Log Scale	0.552
95% t UCL (Assumes normality)	1.889	95% H-Stat UCL	3.183

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.881	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:55
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	1.3	Mean	1.912
Maximum	2.76	Median	1.83
SD	0.539	Std. Error of Mean	0.241
Coefficient of Variation	0.282	Skewness	0.982

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.941	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.242	Lilliefors GOF Test
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.425	95% Adjusted-CLT UCL (Chen-1995)	2.421
		95% Modified-t UCL (Johnson-1978)	2.443

Gamma GOF Test

A-D Test Statistic	0.238	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.203	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.62	k star (bias corrected MLE)	6.782
Theta hat (MLE)	0.115	Theta star (bias corrected MLE)	0.282
nu hat (MLE)	166.2	nu star (bias corrected)	67.82
MLE Mean (bias corrected)	1.912	MLE Sd (bias corrected)	0.734
		Approximate Chi Square Value (0.05)	49.87
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	43.21

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.6	95% Adjusted Gamma UCL (use when n<50)	3.001

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.262	Mean of logged Data	0.618
Maximum of Logged Data	1.015	SD of logged Data	0.274

Assuming Lognormal Distribution

95% H-UCL	2.653	90% Chebyshev (MVUE) UCL	2.61
95% Chebyshev (MVUE) UCL	2.927	97.5% Chebyshev (MVUE) UCL	3.367
99% Chebyshev (MVUE) UCL	4.23		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.308	95% Jackknife UCL	2.425
95% Standard Bootstrap UCL	2.267	95% Bootstrap-t UCL	2.572
95% Hall's Bootstrap UCL	4.682	95% Percentile Bootstrap UCL	2.298
95% BCA Bootstrap UCL	2.39		
90% Chebyshev(Mean, Sd) UCL	2.635	95% Chebyshev(Mean, Sd) UCL	2.962
97.5% Chebyshev(Mean, Sd) UCL	3.416	99% Chebyshev(Mean, Sd) UCL	4.309

Suggested UCL to Use

95% Student's-t UCL	2.425

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A72 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 11:56
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operation:	2000

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	386	Mean	650.8
Maximum	858	Median	646
SD	175.9	Std. Error of Mean	78.66
Coefficient of Variation	0.27	Skewness	-0.674

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.222	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	818.5	95% Adjusted-CLT UCL (Chen-1995)	754.9
		95% Modified-t UCL (Johnson-1978)	814.5

Gamma GOF Test

A-D Test Statistic	0.309	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.251	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.95	k star (bias corrected MLE)	6.112
Theta hat (MLE)	43.54	Theta star (bias corrected MLE)	106.5
nu hat (MLE)	149.5	nu star (bias corrected)	61.12
MLE Mean (bias corrected)	650.8	MLE Sd (bias corrected)	263.2
		Approximate Chi Square Value (0.05)	44.14
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	37.92

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	901.1	95% Adjusted Gamma UCL (use when n<50)	1049

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.912	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.272	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.956	Mean of logged Data	6.444
Maximum of Logged Data	6.755	SD of logged Data	0.302

Assuming Lognormal Distribution

95% H-UCL	947.9	90% Chebyshev (MVUE) UCL	916.4
95% Chebyshev (MVUE) UCL	1036	97.5% Chebyshev (MVUE) UCL	1202
99% Chebyshev (MVUE) UCL	1528		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	780.2	95% Jackknife UCL	818.5
95% Standard Bootstrap UCL	763.8	95% Bootstrap-t UCL	797.7
95% Hall's Bootstrap UCL	794	95% Percentile Bootstrap UCL	765.6
95% BCA Bootstrap UCL	745.2		
90% Chebyshev(Mean, Sd) UCL	886.8	95% Chebyshev(Mean, Sd) UCL	993.7
97.5% Chebyshev(Mean, Sd) UCL	1142	99% Chebyshev(Mean, Sd) UCL	1433

Suggested UCL to Use

95% Student's-t UCL	818.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Al in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:25
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	6770	Mean	17123
Maximum	40700	Median	10510
SD	15852	Std. Error of Mean	7926
Coefficient of Variation	0.926	Skewness	1.9

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.748	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.381	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	35775	95% Adjusted-CLT UCL (Chen-1995)	38205
		95% Modified-t UCL (Johnson-1978)	37030

Gamma GOF Test		
A-D Test Statistic	0.515	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.353	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	2.05	k star (bias corrected MLE)	0.679
Theta hat (MLE)	8354	Theta star (bias corrected MLE)	25214
nu hat (MLE)	16.4	nu star (bias corrected)	5.433
MLE Mean (bias corrected)	17123	MLE Sd (bias corrected)	20778
		Approximate Chi Square Value (0.05)	1.357
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	68540	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.305	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	8.82	Mean of logged Data	9.485
Maximum of Logged Data	10.61	SD of logged Data	0.786

Assuming Lognormal Distribution			
95% H-UCL	201468	90% Chebyshev (MVUE) UCL	34933
95% Chebyshev (MVUE) UCL	43315	97.5% Chebyshev (MVUE) UCL	54949
99% Chebyshev (MVUE) UCL	77801		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	30160	95% Jackknife UCL	35775
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	40900	95% Chebyshev(Mean, Sd) UCL	51671
97.5% Chebyshev(Mean, Sd) UCL	66620	99% Chebyshev(Mean, Sd) UCL	95985

Suggested UCL to Use

95% Student's-t UCL	35775

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets. For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:26
From File	WorkSheet.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	20.5	Mean	27.93
Maximum	33.8	Median	28.7
SD	6.092	Std. Error of Mean	3.046
Coefficient of Variation	0.218	Skewness	-0.466

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.243	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	35.09	95% Adjusted-CLT UCL (Chen-1995)	32.18
		95% Modified-t UCL (Johnson-1978)	34.97

Gamma GOF Test

A-D Test Statistic	0.31	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.278	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	26.51	k star (bias corrected MLE)	6.794
Theta hat (MLE)	1.053	Theta star (bias corrected MLE)	4.11
nu hat (MLE)	212.1	nu star (bias corrected)	54.35
MLE Mean (bias corrected)	27.93	MLE Sd (bias corrected)	10.71
		Approximate Chi Square Value (0.05)	38.41
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	39.51	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.247	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.02	Mean of logged Data	3.311
Maximum of Logged Data	3.52	SD of logged Data	0.228

Assuming Lognormal Distribution

95% H-UCL	39.34	90% Chebyshev (MVUE) UCL	37.47
95% Chebyshev (MVUE) UCL	41.79	97.5% Chebyshev (MVUE) UCL	47.79
99% Chebyshev (MVUE) UCL	59.56		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	32.94	95% Jackknife UCL	35.09
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	37.06	95% Chebyshev(Mean, Sd) UCL	41.2
97.5% Chebyshev(Mean, Sd) UCL	46.95	99% Chebyshev(Mean, Sd) UCL	58.23

Suggested UCL to Use

95% Student's-t UCL	35.09

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 12:30		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.7	Mean	4.01
Maximum	5.6	Median	3.87
SD	1.21	Std. Error of Mean	0.605
Coefficient of Variation	0.302	Skewness	0.649

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.22	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.433	95% Adjusted-CLT UCL (Chen-1995)	5.214
		95% Modified-t UCL (Johnson-1978)	5.466
Gamma GOF Test			
A-D Test Statistic	0.213	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.182	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	14.85	k star (bias corrected MLE)	3.88
Theta hat (MLE)	0.27	Theta star (bias corrected MLE)	1.034
nu hat (MLE)	118.8	nu star (bias corrected)	31.04
MLE Mean (bias corrected)	4.01	MLE Sd (bias corrected)	2.036
		Approximate Chi Square Value (0.05)	19.31
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.445	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.995	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.993	Mean of logged Data	1.355
Maximum of Logged Data	1.723	SD of logged Data	0.302
Assuming Lognormal Distribution			
95% H-UCL	6.588	90% Chebyshev (MVUE) UCL	5.812
95% Chebyshev (MVUE) UCL	6.629	97.5% Chebyshev (MVUE) UCL	7.762
99% Chebyshev (MVUE) UCL	9.988		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.005	95% Jackknife UCL	5.433
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.824	95% Chebyshev(Mean, Sd) UCL	6.646
97.5% Chebyshev(Mean, Sd) UCL	7.787	99% Chebyshev(Mean, Sd) UCL	10.03

Suggested UCL to Use

95% Student's-t UCL	5.433

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:36
From File	WorkSheet.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	113	Mean	199
Maximum	284	Median	199.5
SD	72.4	Std. Error of Mean	36.2
Coefficient of Variation	0.364	Skewness	-0.0356

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	1	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.133	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	284.2	95% Adjusted-CLT UCL (Chen-1995)	257.9
		95% Modified-t UCL (Johnson-1978)	284.1

Gamma GOF Test

A-D Test Statistic	0.208	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.288	k star (bias corrected MLE)	2.489
Theta hat (MLE)	21.43	Theta star (bias corrected MLE)	79.97
nu hat (MLE)	74.3	nu star (bias corrected)	19.91
MLE Mean (bias corrected)	199	MLE Sd (bias corrected)	126.1
		Approximate Chi Square Value (0.05)	10.78
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	367.4	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.181	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.727	Mean of logged Data	5.239
Maximum of Logged Data	5.649	SD of logged Data	0.393

Assuming Lognormal Distribution

95% H-UCL	415.1	90% Chebyshev (MVUE) UCL	315.6
95% Chebyshev (MVUE) UCL	368.3	97.5% Chebyshev (MVUE) UCL	441.3
99% Chebyshev (MVUE) UCL	584.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	258.5	95% Jackknife UCL	284.2
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	307.6	95% Chebyshev(Mean, Sd) UCL	356.8
97.5% Chebyshev(Mean, Sd) UCL	425.1	99% Chebyshev(Mean, Sd) UCL	559.2

Suggested UCL to Use

95% Student's-t UCL	284.2

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	3/2/2015 12:44		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
General Statistics			
Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.83	Mean	3.988
Maximum	5.6	Median	3.76
SD	1.18	Std. Error of Mean	0.59
Coefficient of Variation	0.296	Skewness	1.024

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.239	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.376	95% Adjusted-CLT UCL (Chen-1995)	5.281
		95% Modified-t UCL (Johnson-1978)	5.427
Gamma GOF Test			
A-D Test Statistic	0.238	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.204	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.09	k star (bias corrected MLE)	4.19
Theta hat (MLE)	0.248	Theta star (bias corrected MLE)	0.952
nu hat (MLE)	128.7	nu star (bias corrected)	33.52
MLE Mean (bias corrected)	3.988	MLE Sd (bias corrected)	1.948
		Approximate Chi Square Value (0.05)	21.28
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6.281	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.04	Mean of logged Data	1.352
Maximum of Logged Data	1.723	SD of logged Data	0.286
Assuming Lognormal Distribution			
95% H-UCL	6.323	90% Chebyshev (MVUE) UCL	5.685
95% Chebyshev (MVUE) UCL	6.456	97.5% Chebyshev (MVUE) UCL	7.525
99% Chebyshev (MVUE) UCL	9.626		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.958	95% Jackknife UCL	5.376
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.758	95% Chebyshev(Mean, Sd) UCL	6.56
97.5% Chebyshev(Mean, Sd) UCL	7.673	99% Chebyshev(Mean, Sd) UCL	9.859
Suggested UCL to Use			
95% Student's-t UCL	5.376		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:15
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.02	Mean	0.0353
Maximum	0.05	Median	0.036
SD	0.015	Std. Error of Mean	0.00867
Coefficient of Variation	0.425	Skewness	-0.199

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.999	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.184	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0606	95% Adjusted-CLT UCL (Chen-1995)	0.0485
		95% Modified-t UCL (Johnson-1978)	0.0605
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	7.544	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00468	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	45.27	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-3.912	Mean of logged Data	-3.411
Maximum of Logged Data	-2.996	SD of logged Data	0.464
Assuming Lognormal Distribution			
95% H-UCL	0.265	90% Chebyshev (MVUE) UCL	0.0632
95% Chebyshev (MVUE) UCL	0.0758	97.5% Chebyshev (MVUE) UCL	0.0932
99% Chebyshev (MVUE) UCL	0.127		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0.0496	95% Jackknife UCL	0.0606
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0613	95% Chebyshev(Mean, Sd) UCL	0.0731
97.5% Chebyshev(Mean, Sd) UCL	0.0895	99% Chebyshev(Mean, Sd) UCL	0.122

Suggested UCL to Use

95% Student's-t UCL	0.0606

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:39
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	297	Mean	513
Maximum	729	Median	513
SD	187.5	Std. Error of Mean	93.75
Coefficient of Variation	0.366	Skewness	0

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.989	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.161	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	733.6	95% Adjusted-CLT UCL (Chen-1995)	667.2
		95% Modified-t UCL (Johnson-1978)	733.6
Gamma GOF Test			
A-D Test Statistic	0.217	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.209	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	9.315	k star (bias corrected MLE)	2.496
Theta hat (MLE)	55.07	Theta star (bias corrected MLE)	205.6
nu hat (MLE)	74.52	nu star (bias corrected)	19.96
MLE Mean (bias corrected)	513	MLE Sd (bias corrected)	324.7
		Approximate Chi Square Value (0.05)	10.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	946.1	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.977	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.192	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	5.694	Mean of logged Data	6.186
Maximum of Logged Data	6.592	SD of logged Data	0.391
Assuming Lognormal Distribution			
95% H-UCL	1063	90% Chebyshev (MVUE) UCL	811.6
95% Chebyshev (MVUE) UCL	946.5	97.5% Chebyshev (MVUE) UCL	1134
99% Chebyshev (MVUE) UCL	1501		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	667.2	95% Jackknife UCL	733.6
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	794.3	95% Chebyshev(Mean, Sd) UCL	921.7
97.5% Chebyshev(Mean, Sd) UCL	1098	99% Chebyshev(Mean, Sd) UCL	1446

Suggested UCL to Use

95% Student's-t UCL	733.6

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:40
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2780	Mean	4340
Maximum	7120	Median	3730
SD	1936	Std. Error of Mean	967.9
Coefficient of Variation	0.446	Skewness	1.527

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.866	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6618	95% Adjusted-CLT UCL (Chen-1995)	6722
		95% Modified-t UCL (Johnson-1978)	6741

Gamma GOF Test

A-D Test Statistic	0.345	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.254	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	7.696	k star (bias corrected MLE)	2.091
Theta hat (MLE)	563.9	Theta star (bias corrected MLE)	2076
nu hat (MLE)	61.57	nu star (bias corrected)	16.73
MLE Mean (bias corrected)	4340	MLE Sd (bias corrected)	3001
		Approximate Chi Square Value (0.05)	8.477
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8563	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.231	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	7.93	Mean of logged Data	8.309
Maximum of Logged Data	8.871	SD of logged Data	0.408

Assuming Lognormal Distribution

95% H-UCL	9408	90% Chebyshev (MVUE) UCL	6932
95% Chebyshev (MVUE) UCL	8115	97.5% Chebyshev (MVUE) UCL	9757
99% Chebyshev (MVUE) UCL	12983		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5932	95% Jackknife UCL	6618
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7244	95% Chebyshev(Mean, Sd) UCL	8559
97.5% Chebyshev(Mean, Sd) UCL	10385	99% Chebyshev(Mean, Sd) UCL	13971

Suggested UCL to Use

95% Student's-t UCL	6618

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:42
From File	WorkSheet.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	5.5	Mean	6.4
Maximum	7.19	Median	6.455
SD	0.761	Std. Error of Mean	0.38
Coefficient of Variation	0.119	Skewness	-0.283

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.959	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.295	95% Adjusted-CLT UCL (Chen-1995)	6.968
		95% Modified-t UCL (Johnson-1978)	7.286

Gamma GOF Test

A-D Test Statistic	0.268	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.252	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	92.73	k star (bias corrected MLE)	23.35
Theta hat (MLE)	0.069	Theta star (bias corrected MLE)	0.274
nu hat (MLE)	741.9	nu star (bias corrected)	186.8
MLE Mean (bias corrected)	6.4	MLE Sd (bias corrected)	1.324
		Approximate Chi Square Value (0.05)	156.2
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.655	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.224	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.705	Mean of logged Data	1.851
Maximum of Logged Data	1.973	SD of logged Data	0.121

Assuming Lognormal Distribution

95% H-UCL	7.507	90% Chebyshev (MVUE) UCL	7.557
95% Chebyshev (MVUE) UCL	8.08	97.5% Chebyshev (MVUE) UCL	8.808
99% Chebyshev (MVUE) UCL	10.24		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.026	95% Jackknife UCL	7.295
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7.541	95% Chebyshev(Mean, Sd) UCL	8.058
97.5% Chebyshev(Mean, Sd) UCL	8.776	99% Chebyshev(Mean, Sd) UCL	10.19

Suggested UCL to Use

95% Student's-t UCL	7.295

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Se in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:43
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.717	Minimum Non-Detect	1
Maximum Detect	1.43	Maximum Non-Detect	1.02
Variance Detects	0.254	Percent Non-Detects	50%
Mean Detects	1.074	SD Detects	0.504
Median Detects	1.074	CV Detects	0.47
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.0125	SD of Logged Detects	0.488

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.895	Standard Error of Mean	0.218
SD	0.309	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.409	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.254	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.55	95% KM Chebyshev UCL	1.847
97.5% KM Chebyshev UCL	2.259	99% KM Chebyshev UCL	3.067

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.721	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.123	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.88	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	8.408	nu hat (KM)	67.27
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (67.27, α)	49.39	Adjusted Chi Square Value (67.27, β)	41.13
95% Gamma Approximate KM-UCL (use when n>=50)	1.219	95% Gamma Adjusted KM-UCL (use when n<50)	1.464

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.895	Mean in Log Scale	-0.16
SD in Original Scale	0.357	SD in Log Scale	0.345
95% t UCL (assumes normality of ROS data)	1.315	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	1.627		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.789	Mean in Log Scale	-0.335
SD in Original Scale	0.439	SD in Log Scale	0.491
95% t UCL (Assumes normality)	1.305	95% H-Stat UCL	2.243

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.409	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:45
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.24	Mean	1.923
Maximum	2.78	Median	1.835
SD	0.75	Std. Error of Mean	0.375
Coefficient of Variation	0.39	Skewness	0.297

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.884	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.277	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.805	95% Adjusted-CLT UCL (Chen-1995)	2.599
		95% Modified-t UCL (Johnson-1978)	2.814

Gamma GOF Test

A-D Test Statistic	0.418	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.307	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.664	k star (bias corrected MLE)	2.333
Theta hat (MLE)	0.222	Theta star (bias corrected MLE)	0.824
nu hat (MLE)	69.31	nu star (bias corrected)	18.66
MLE Mean (bias corrected)	1.923	MLE Sd (bias corrected)	1.259
		Approximate Chi Square Value (0.05)	9.871
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.635	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.215	Mean of logged Data	0.595
Maximum of Logged Data	1.022	SD of logged Data	0.398

Assuming Lognormal Distribution

95% H-UCL	4.059	90% Chebyshev (MVUE) UCL	3.056
95% Chebyshev (MVUE) UCL	3.569	97.5% Chebyshev (MVUE) UCL	4.282
99% Chebyshev (MVUE) UCL	5.682		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.539	95% Jackknife UCL	2.805
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3.047	95% Chebyshev(Mean, Sd) UCL	3.557
97.5% Chebyshev(Mean, Sd) UCL	4.264	99% Chebyshev(Mean, Sd) UCL	5.653

Suggested UCL to Use

95% Student's-t UCL	2.805

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A73 below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 12:46
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	749	Mean	1049
Maximum	1450	Median	999
SD	292	Std. Error of Mean	146
Coefficient of Variation	0.278	Skewness	0.992

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.317	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1393	95% Adjusted-CLT UCL (Chen-1995)	1367
		95% Modified-t UCL (Johnson-1978)	1405
Gamma GOF Test			
A-D Test Statistic	0.354	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.299	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	18.06	k star (bias corrected MLE)	4.682
Theta hat (MLE)	58.09	Theta star (bias corrected MLE)	224.1
nu hat (MLE)	144.5	nu star (bias corrected)	37.46
MLE Mean (bias corrected)	1049	MLE Sd (bias corrected)	484.9
		Approximate Chi Square Value (0.05)	24.44
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1608	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.28	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.619	Mean of logged Data	6.928
Maximum of Logged Data	7.279	SD of logged Data	0.271
Assuming Lognormal Distribution			
95% H-UCL	1609	90% Chebyshev (MVUE) UCL	1472
95% Chebyshev (MVUE) UCL	1664	97.5% Chebyshev (MVUE) UCL	1930
99% Chebyshev (MVUE) UCL	2454		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1289	95% Jackknife UCL	1393
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1487	95% Chebyshev(Mean, Sd) UCL	1686
97.5% Chebyshev(Mean, Sd) UCL	1961	99% Chebyshev(Mean, Sd) UCL	2502

Suggested UCL to Use

95% Student's-t UCL	1393

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:09
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	6620	Mean	16373
Maximum	31900	Median	10600
SD	13593	Std. Error of Mean	7848
Coefficient of Variation	0.83	Skewness	1.566

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.331	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	39289	95% Adjusted-CLT UCL (Chen-1995)	36866
		95% Modified-t UCL (Johnson-1978)	40472
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	2.381	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6877	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	14.29	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.269	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.798	Mean of logged Data	9.479
Maximum of Logged Data	10.37	SD of logged Data	0.807
Assuming Lognormal Distribution			
95% H-UCL	7347437	90% Chebyshev (MVUE) UCL	36910
95% Chebyshev (MVUE) UCL	46345	97.5% Chebyshev (MVUE) UCL	59441
99% Chebyshev (MVUE) UCL	85165		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	29282	95% Jackknife UCL	39289
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	39917	95% Chebyshev(Mean, Sd) UCL	50581
97.5% Chebyshev(Mean, Sd) UCL	65383	99% Chebyshev(Mean, Sd) UCL	94459

Suggested UCL to Use

95% Student's-t UCL	39289

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:10		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	19.9	Mean	29.9
Maximum	39.4	Median	30.4
SD	9.76	Std. Error of Mean	5.635
Coefficient of Variation	0.326	Skewness	-0.23

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.998	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.187	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	46.35	95% Adjusted-CLT UCL (Chen-1995)	38.37
		95% Modified-t UCL (Johnson-1978)	46.23

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	13.25	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.257	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	79.49	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.23	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.991	Mean of logged Data	3.36
Maximum of Logged Data	3.674	SD of logged Data	0.345

Assuming Lognormal Distribution

95% H-UCL	93.07	90% Chebyshev (MVUE) UCL	47.55
95% Chebyshev (MVUE) UCL	55.52	97.5% Chebyshev (MVUE) UCL	66.6
99% Chebyshev (MVUE) UCL	88.35		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	39.17	95% Jackknife UCL	46.35
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	46.8	95% Chebyshev(Mean, Sd) UCL	54.46
97.5% Chebyshev(Mean, Sd) UCL	65.09	99% Chebyshev(Mean, Sd) UCL	85.96

Suggested UCL to Use

95% Student's-t UCL	46.35

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:10		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics			
Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2.72	Mean	3.507
Maximum	4.24	Median	3.56
SD	0.761	Std. Error of Mean	0.44
Coefficient of Variation	0.217	Skewness	-0.314

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.996	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.195	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.79	95% Adjusted-CLT UCL (Chen-1995)	4.145
		95% Modified-t UCL (Johnson-1978)	4.777
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	30.75	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.114	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	184.5	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.223	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.001	Mean of logged Data	1.238
Maximum of Logged Data	1.445	SD of logged Data	0.224
Assuming Lognormal Distribution			
95% H-UCL	6.116	90% Chebyshev (MVUE) UCL	4.858
95% Chebyshev (MVUE) UCL	5.469	97.5% Chebyshev (MVUE) UCL	6.318
99% Chebyshev (MVUE) UCL	7.986		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.23	95% Jackknife UCL	4.79
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4.825	95% Chebyshev(Mean, Sd) UCL	5.423
97.5% Chebyshev(Mean, Sd) UCL	6.252	99% Chebyshev(Mean, Sd) UCL	7.881

Suggested UCL to Use	
95% Student's-t UCL	4.79

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	3.68	Mean	4.473
Maximum	5.02	Median	4.72
SD	0.703	Std. Error of Mean	0.406
Coefficient of Variation	0.157	Skewness	-1.384

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.304	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.659	95% Adjusted-CLT UCL (Chen-1995)	4.794
		95% Modified-t UCL (Johnson-1978)	5.605
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	57.31	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0781	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	343.9	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.315	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.303	Mean of logged Data	1.489
Maximum of Logged Data	1.613	SD of logged Data	0.164
Assuming Lognormal Distribution			
95% H-UCL	6.422	90% Chebyshev (MVUE) UCL	5.744
95% Chebyshev (MVUE) UCL	6.319	97.5% Chebyshev (MVUE) UCL	7.118
99% Chebyshev (MVUE) UCL	8.686		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.141	95% Jackknife UCL	5.659
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.691	95% Chebyshev(Mean, Sd) UCL	6.243
97.5% Chebyshev(Mean, Sd) UCL	7.009	99% Chebyshev(Mean, Sd) UCL	8.513

Suggested UCL to Use

95% Student's-t UCL	5.659

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:10		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	98.8	Mean	176.9
Maximum	292	Median	140
SD	101.8	Std. Error of Mean	58.75
Coefficient of Variation	0.575	Skewness	1.418

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.308	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	348.5	95% Adjusted-CLT UCL (Chen-1995)	325
		95% Modified-t UCL (Johnson-1978)	356.5
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	4.91	k star (bias corrected MLE)	N/A
Theta hat (MLE)	36.04	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	29.46	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.593	Mean of logged Data	5.07
Maximum of Logged Data	5.677	SD of logged Data	0.553
Assuming Lognormal Distribution			
95% H-UCL	3088	90% Chebyshev (MVUE) UCL	338.4
95% Chebyshev (MVUE) UCL	411.9	97.5% Chebyshev (MVUE) UCL	514
99% Chebyshev (MVUE) UCL	714.6		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	273.6	95% Jackknife UCL	348.5
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	353.2	95% Chebyshev(Mean, Sd) UCL	433
97.5% Chebyshev(Mean, Sd) UCL	543.8	99% Chebyshev(Mean, Sd) UCL	761.5

Suggested UCL to Use

95% Student's-t UCL	348.5

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:11
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics			
Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	468	Mean	533.7
Maximum	593	Median	540
SD	62.74	Std. Error of Mean	36.22
Coefficient of Variation	0.118	Skewness	-0.45

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.992	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	639.4	95% Adjusted-CLT UCL (Chen-1995)	583.2
		95% Modified-t UCL (Johnson-1978)	637.9
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	106.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	5.002	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	640.1	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.222	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.148	Mean of logged Data	6.275
Maximum of Logged Data	6.385	SD of logged Data	0.119
Assuming Lognormal Distribution			
95% H-UCL	679.3	90% Chebyshev (MVUE) UCL	643.7
95% Chebyshev (MVUE) UCL	693.5	97.5% Chebyshev (MVUE) UCL	762.7
99% Chebyshev (MVUE) UCL	898.5		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	593.2	95% Jackknife UCL	639.4
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	642.3	95% Chebyshev(Mean, Sd) UCL	691.6
97.5% Chebyshev(Mean, Sd) UCL	759.9	99% Chebyshev(Mean, Sd) UCL	894.1

Suggested UCL to Use

95% Student's-t UCL	639.4

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:11		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2480	Mean	3143
Maximum	4340	Median	2610
SD	1038	Std. Error of Mean	599.5
Coefficient of Variation	0.33	Skewness	1.702

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.802	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.363	Lilliefors GOF Test
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4894	95% Adjusted-CLT UCL (Chen-1995)	4759
		95% Modified-t UCL (Johnson-1978)	4992

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	15.11	k star (bias corrected MLE)	N/A
Theta hat (MLE)	208	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	90.66	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.818	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.356	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.816	Mean of logged Data	8.02
Maximum of Logged Data	8.376	SD of logged Data	0.309

Assuming Lognormal Distribution

95% H-UCL	7994	90% Chebyshev (MVUE) UCL	4799
95% Chebyshev (MVUE) UCL	5552	97.5% Chebyshev (MVUE) UCL	6597
99% Chebyshev (MVUE) UCL	8649		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4129	95% Jackknife UCL	4894
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4942	95% Chebyshev(Mean, Sd) UCL	5757
97.5% Chebyshev(Mean, Sd) UCL	6887	99% Chebyshev(Mean, Sd) UCL	9108

Suggested UCL to Use

95% Student's-t UCL	4894

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:11		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	8.16	Mean	10.01
Maximum	12.1	Median	9.78
SD	1.98	Std. Error of Mean	1.143
Coefficient of Variation	0.198	Skewness	0.523

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.99	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.214	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13.35	95% Adjusted-CLT UCL (Chen-1995)	12.26
		95% Modified-t UCL (Johnson-1978)	13.41

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics			
k hat (MLE)	38.66	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.259	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	232	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.998	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.188	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	2.099	Mean of logged Data	2.291
Maximum of Logged Data	2.493	SD of logged Data	0.197

Assuming Lognormal Distribution			
95% H-UCL	15.91	90% Chebyshev (MVUE) UCL	13.42
95% Chebyshev (MVUE) UCL	14.96	97.5% Chebyshev (MVUE) UCL	17.1
99% Chebyshev (MVUE) UCL	21.3		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	11.89	95% Jackknife UCL	13.35
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.44	95% Chebyshev(Mean, Sd) UCL	15
97.5% Chebyshev(Mean, Sd) UCL	17.15	99% Chebyshev(Mean, Sd) UCL	21.39

Suggested UCL to Use

95% Student's-t UCL	13.35

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:12
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1.25	Mean	1.997
Maximum	3.09	Median	1.65
SD	0.968	Std. Error of Mean	0.559
Coefficient of Variation	0.485	Skewness	1.405

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.307	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.628	95% Adjusted-CLT UCL (Chen-1995)	3.4
		95% Modified-t UCL (Johnson-1978)	3.704
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	6.909	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.289	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	41.45	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.266	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.223	Mean of logged Data	0.617
Maximum of Logged Data	1.128	SD of logged Data	0.464
Assuming Lognormal Distribution			
95% H-UCL	14.82	90% Chebyshev (MVUE) UCL	3.545
95% Chebyshev (MVUE) UCL	4.25	97.5% Chebyshev (MVUE) UCL	5.229
99% Chebyshev (MVUE) UCL	7.15		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2.916	95% Jackknife UCL	3.628
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3.673	95% Chebyshev(Mean, Sd) UCL	4.432
97.5% Chebyshev(Mean, Sd) UCL	5.486	99% Chebyshev(Mean, Sd) UCL	7.556

Suggested UCL to Use

95% Student's-t UCL	3.628

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A73B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:12		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	659	Mean	1114
Maximum	1720	Median	964
SD	546.2	Std. Error of Mean	315.4
Coefficient of Variation	0.49	Skewness	1.145

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.275	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2035	95% Adjusted-CLT UCL (Chen-1995)	1856
		95% Modified-t UCL (Johnson-1978)	2070
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	6.514	k star (bias corrected MLE)	N/A
Theta hat (MLE)	171.1	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	39.09	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.491	Mean of logged Data	6.937
Maximum of Logged Data	7.45	SD of logged Data	0.483
Assuming Lognormal Distribution			
95% H-UCL	9849	90% Chebyshev (MVUE) UCL	2016
95% Chebyshev (MVUE) UCL	2425	97.5% Chebyshev (MVUE) UCL	2994
99% Chebyshev (MVUE) UCL	4110		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1633	95% Jackknife UCL	2035
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2060	95% Chebyshev(Mean, Sd) UCL	2489
97.5% Chebyshev(Mean, Sd) UCL	3084	99% Chebyshev(Mean, Sd) UCL	4252

Suggested UCL to Use

95% Student's-t UCL	2035

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options				
Date/Time of Computation	2/18/2015 13:57			
From File	WorkSheet.xls			
Full Precision	OFF			
Confidence Coefficient	95%			
Number of Bootstrap Operations	2000			
General Statistics				
Total Number of Observations	3	Number of Distinct Observations	3	
		Number of Missing Observations	0	
Minimum	6640	Mean	20820	
Maximum	48600	Median	7220	
SD	24060	Std. Error of Mean	13891	
Coefficient of Variation	1.156	Skewness	1.731	

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.76	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.381	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	61382	95% Adjusted-CLT UCL (Chen-1995)	58502
		95% Modified-t UCL (Johnson-1978)	63695
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	1.248	k star (bias corrected MLE)	N/A
Theta hat (MLE)	16682	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	7.488	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.781	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.372	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.801	Mean of logged Data	9.492
Maximum of Logged Data	10.79	SD of logged Data	1.126
Assuming Lognormal Distribution			
95% H-UCL	3.02E+09	90% Chebyshev (MVUE) UCL	52502
95% Chebyshev (MVUE) UCL	67461	97.5% Chebyshev (MVUE) UCL	88224
99% Chebyshev (MVUE) UCL	129007		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	43669	95% Jackknife UCL	61382
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	62493	95% Chebyshev(Mean, Sd) UCL	81370
97.5% Chebyshev(Mean, Sd) UCL	107569	99% Chebyshev(Mean, Sd) UCL	159034
Suggested UCL to Use			
95% Student's-t UCL	61382		

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	9.22	Mean	19.91
Maximum	37.2	Median	13.3
SD	15.11	Std. Error of Mean	8.727
Coefficient of Variation	0.759	Skewness	1.591

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.857	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.336	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	45.39	95% Adjusted-CLT UCL (Chen-1995)	42.83
		95% Modified-t UCL (Johnson-1978)	46.72

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.895	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.877	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.37	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.221	Mean of logged Data	2.808
Maximum of Logged Data	3.616	SD of logged Data	0.723

Assuming Lognormal Distribution

95% H-UCL	2668	90% Chebyshev (MVUE) UCL	42.69
95% Chebyshev (MVUE) UCL	53.14	97.5% Chebyshev (MVUE) UCL	67.65
99% Chebyshev (MVUE) UCL	96.16		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	34.26	95% Jackknife UCL	45.39
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	46.09	95% Chebyshev(Mean, Sd) UCL	57.94
97.5% Chebyshev(Mean, Sd) UCL	74.4	99% Chebyshev(Mean, Sd) UCL	106.7

Suggested UCL to Use

95% Student's-t UCL	45.39

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1.99	Mean	5.047
Maximum	10.5	Median	2.65
SD	4.734	Std. Error of Mean	2.733
Coefficient of Variation	0.938	Skewness	1.694

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.808	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.36	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13.03	95% Adjusted-CLT UCL (Chen-1995)	12.4
		95% Modified-t UCL (Johnson-1978)	13.47

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.931	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.613	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	11.59	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.325	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.688	Mean of logged Data	1.338
Maximum of Logged Data	2.351	SD of logged Data	0.889

Assuming Lognormal Distribution

95% H-UCL	8316	90% Chebyshev (MVUE) UCL	11.75
95% Chebyshev (MVUE) UCL	14.86	97.5% Chebyshev (MVUE) UCL	19.18
99% Chebyshev (MVUE) UCL	27.66		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.543	95% Jackknife UCL	13.03
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.25	95% Chebyshev(Mean, Sd) UCL	16.96
97.5% Chebyshev(Mean, Sd) UCL	22.12	99% Chebyshev(Mean, Sd) UCL	32.24

Suggested UCL to Use

95% Student's-t UCL	13.03

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:57
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	67	Mean	187.6
Maximum	413	Median	82.7
SD	195.4	Std. Error of Mean	112.8
Coefficient of Variation	1.042	Skewness	1.719

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.784	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.371	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	517	95% Adjusted-CLT UCL (Chen-1995)	492.8
		95% Modified-t UCL (Johnson-1978)	535.6
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	1.562	k star (bias corrected MLE)	N/A
Theta hat (MLE)	120.1	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	9.373	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.347	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	4.205	Mean of logged Data	4.881
Maximum of Logged Data	6.023	SD of logged Data	0.995
Assuming Lognormal Distribution			
95% H-UCL	2000919	90% Chebyshev (MVUE) UCL	454.7
95% Chebyshev (MVUE) UCL	579.6	97.5% Chebyshev (MVUE) UCL	752.9
99% Chebyshev (MVUE) UCL	1093		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	373.1	95% Jackknife UCL	517
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	526	95% Chebyshev(Mean, Sd) UCL	679.3
97.5% Chebyshev(Mean, Sd) UCL	892.1	99% Chebyshev(Mean, Sd) UCL	1310

Suggested UCL to Use

95% Student's-t UCL	517

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:44
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	5.01	Mean	5.207
Maximum	5.45	Median	5.16
SD	0.224	Std. Error of Mean	0.129
Coefficient of Variation	0.043	Skewness	0.898

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.967	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.584	95% Adjusted-CLT UCL (Chen-1995)	5.491
		95% Modified-t UCL (Johnson-1978)	5.595
Gamma GOF Test			
Not Enough Data to Perform GOF Test			
Gamma Statistics			
k hat (MLE)	819.2	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00636	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	4915	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.245	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.611	Mean of logged Data	1.649
Maximum of Logged Data	1.696	SD of logged Data	0.0427
Assuming Lognormal Distribution			
95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	5.592
95% Chebyshev (MVUE) UCL	5.766	97.5% Chebyshev (MVUE) UCL	6.008
99% Chebyshev (MVUE) UCL	6.484		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5.419	95% Jackknife UCL	5.584
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.594	95% Chebyshev(Mean, Sd) UCL	5.77
97.5% Chebyshev(Mean, Sd) UCL	6.013	99% Chebyshev(Mean, Sd) UCL	6.492

Suggested UCL to Use

95% Student's-t UCL	5.584

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options				
Date/Time of Computation	2/18/2015 13:58			
From File	WorkSheet.xls			
Full Precision	OFF			
Confidence Coefficient	95%			
Number of Bootstrap Operations	2000			

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	98	Mean	295.7
Maximum	435	Median	354
SD	175.9	Std. Error of Mean	101.6
Coefficient of Variation	0.595	Skewness	-1.328

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.297	Lilliefors GOF Test
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	592.2	95% Adjusted-CLT UCL (Chen-1995)	379.5
		95% Modified-t UCL (Johnson-1978)	579.2

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.944	k star (bias corrected MLE)	N/A
Theta hat (MLE)	100.4	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.66	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.339	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.585	Mean of logged Data	5.51
Maximum of Logged Data	6.075	SD of logged Data	0.808

Assuming Lognormal Distribution

95% H-UCL	139915	90% Chebyshev (MVUE) UCL	697.6
95% Chebyshev (MVUE) UCL	876	97.5% Chebyshev (MVUE) UCL	1124
99% Chebyshev (MVUE) UCL	1610		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	462.7	95% Jackknife UCL	592.2
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	600.4	95% Chebyshev(Mean, Sd) UCL	738.4
97.5% Chebyshev(Mean, Sd) UCL	929.9	99% Chebyshev(Mean, Sd) UCL	1306

Suggested UCL to Use

95% Student's-t UCL	592.2

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 13:58		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	2070	Mean	2743
Maximum	3820	Median	2340
SD	942.1	Std. Error of Mean	543.9
Coefficient of Variation	0.343	Skewness	1.573

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.863	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.332	Lilliefors GOF Test
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4332	95% Adjusted-CLT UCL (Chen-1995)	4166
		95% Modified-t UCL (Johnson-1978)	4414

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	13.85	k star (bias corrected MLE)	N/A
Theta hat (MLE)	198	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	83.13	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.314	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.635	Mean of logged Data	7.88
Maximum of Logged Data	8.248	SD of logged Data	0.324

Assuming Lognormal Distribution

95% H-UCL	7558	90% Chebyshev (MVUE) UCL	4256
95% Chebyshev (MVUE) UCL	4944	97.5% Chebyshev (MVUE) UCL	5898
99% Chebyshev (MVUE) UCL	7773		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3638	95% Jackknife UCL	4332
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4375	95% Chebyshev(Mean, Sd) UCL	5114
97.5% Chebyshev(Mean, Sd) UCL	6140	99% Chebyshev(Mean, Sd) UCL	8156

Suggested UCL to Use

95% Student's-t UCL	4332

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	5.93	Mean	9.713
Maximum	16.5	Median	6.71
SD	5.89	Std. Error of Mean	3.401
Coefficient of Variation	0.606	Skewness	1.698

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.805	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.362	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.64	95% Adjusted-CLT UCL (Chen-1995)	18.87
		95% Modified-t UCL (Johnson-1978)	20.2

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	4.658	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.085	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	27.95	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.839	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.345	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.78	Mean of logged Data	2.162
Maximum of Logged Data	2.803	SD of logged Data	0.559

Assuming Lognormal Distribution

95% H-UCL	178.7	90% Chebyshev (MVUE) UCL	18.58
95% Chebyshev (MVUE) UCL	22.64	97.5% Chebyshev (MVUE) UCL	28.27
99% Chebyshev (MVUE) UCL	39.34		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	15.31	95% Jackknife UCL	19.64
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	19.92	95% Chebyshev(Mean, Sd) UCL	24.54
97.5% Chebyshev(Mean, Sd) UCL	30.95	99% Chebyshev(Mean, Sd) UCL	43.55

Suggested UCL to Use

95% Student's-t UCL	19.64

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	1
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.588	Minimum Non-Detect	0.994
Maximum Detect	3.26	Maximum Non-Detect	0.994
Variance Detects	3.57	Percent Non-Detects	33.33%
Mean Detects	1.924	SD Detects	1.889
Median Detects	1.924	CV Detects	0.982
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.325	SD of Logged Detects	1.211

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.479	Standard Error of Mean	1.028
SD	1.26	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.482	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.17	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.564	95% KM Chebyshev UCL	5.962
97.5% KM Chebyshev UCL	7.901	99% KM Chebyshev UCL	11.71

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.667	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.154	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6.667	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.378	nu hat (KM)	8.269
		Adjusted Level of Significance (β)	0.00136
Approximate Chi Square Value (8.27, α)	2.892	Adjusted Chi Square Value (8.27, β)	1.019
95% Gamma Approximate KM-UCL (use when n>=50)	4.228	95% Gamma Adjusted KM-UCL (use when n<50)	11.99

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.479	Mean in Log Scale	0.0399
SD in Original Scale	1.543	SD in Log Scale	0.989
95% t UCL (assumes normality of ROS data)	4.079	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	14069		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.448	Mean in Log Scale	-0.0162
SD in Original Scale	1.57	SD in Log Scale	1.041
95% t UCL (Assumes normality)	4.094	95% H-Stat UCL	37170

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	7.901

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.512	Mean	1.401
Maximum	2.18	Median	1.51
SD	0.839	Std. Error of Mean	0.485
Coefficient of Variation	0.599	Skewness	-0.576

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.987	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.816	95% Adjusted-CLT UCL (Chen-1995)	2.026
		95% Modified-t UCL (Johnson-1978)	2.789

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	3.226	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.434	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	19.35	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.925	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.669	Mean of logged Data	0.174
Maximum of Logged Data	0.779	SD of logged Data	0.753

Assuming Lognormal Distribution

95% H-UCL	294.6	90% Chebyshev (MVUE) UCL	3.166
95% Chebyshev (MVUE) UCL	3.954	97.5% Chebyshev (MVUE) UCL	5.048
99% Chebyshev (MVUE) UCL	7.196		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.198	95% Jackknife UCL	2.816
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2.854	95% Chebyshev(Mean, Sd) UCL	3.513
97.5% Chebyshev(Mean, Sd) UCL	4.427	99% Chebyshev(Mean, Sd) UCL	6.222

Suggested UCL to Use

95% Student's-t UCL	2.816

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A75B below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 13:58
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	578	Mean	2190
Maximum	5320	Median	672
SD	2711	Std. Error of Mean	1565
Coefficient of Variation	1.238	Skewness	1.73

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.765	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.379	Lilliefors GOF Test
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6760	95% Adjusted-CLT UCL (Chen-1995)	6435
		95% Modified-t UCL (Johnson-1978)	7021

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	1.058	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2070	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6.349	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.801	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.364	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.36	Mean of logged Data	7.15
Maximum of Logged Data	8.579	SD of logged Data	1.24

Assuming Lognormal Distribution

95% H-UCL	4.08E+09	90% Chebyshev (MVUE) UCL	5684
95% Chebyshev (MVUE) UCL	7345	97.5% Chebyshev (MVUE) UCL	9652
99% Chebyshev (MVUE) UCL	14182		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4765	95% Jackknife UCL	6760
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6886	95% Chebyshev(Mean, Sd) UCL	9013
97.5% Chebyshev(Mean, Sd) UCL	11965	99% Chebyshev(Mean, Sd) UCL	17764

Suggested UCL to Use

95% Student's-t UCL	6760

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 14:19		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7660	Mean	15428
Maximum	29900	Median	12075
SD	10281	Std. Error of Mean	5141
Coefficient of Variation	0.666	Skewness	1.372

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.855	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.248	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	27525	95% Adjusted-CLT UCL (Chen-1995)	27653
		95% Modified-t UCL (Johnson-1978)	28113

Gamma GOF Test

A-D Test Statistic	0.369	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.396	k star (bias corrected MLE)	1.016
Theta hat (MLE)	4542	Theta star (bias corrected MLE)	15188
nu hat (MLE)	27.17	nu star (bias corrected)	8.126
MLE Mean (bias corrected)	15428	MLE Sd (bias corrected)	15307
		Approximate Chi Square Value (0.05)	2.808
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	44642	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.256	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.944	Mean of logged Data	9.49
Maximum of Logged Data	10.31	SD of logged Data	0.627

Assuming Lognormal Distribution

95% H-UCL	78329	90% Chebyshev (MVUE) UCL	29207
95% Chebyshev (MVUE) UCL	35525	97.5% Chebyshev (MVUE) UCL	44293
99% Chebyshev (MVUE) UCL	61516		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	23883	95% Jackknife UCL	27525
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	30849	95% Chebyshev(Mean, Sd) UCL	37835
97.5% Chebyshev(Mean, Sd) UCL	47531	99% Chebyshev(Mean, Sd) UCL	66576

Suggested UCL to Use

95% Student's-t UCL	27525

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 14:19		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	13.2	Mean	19.35
Maximum	28.5	Median	17.85
SD	6.488	Std. Error of Mean	3.244
Coefficient of Variation	0.335	Skewness	1.283

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.32	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	26.98	95% Adjusted-CLT UCL (Chen-1995)	26.91
		95% Modified-t UCL (Johnson-1978)	27.33
Gamma GOF Test			
A-D Test Statistic	0.343	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.3	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	12.9	k star (bias corrected MLE)	3.392
Theta hat (MLE)	1.5	Theta star (bias corrected MLE)	5.705
nu hat (MLE)	103.2	nu star (bias corrected)	27.14
MLE Mean (bias corrected)	19.35	MLE Sd (bias corrected)	10.51
		Approximate Chi Square Value (0.05)	16.26
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	32.3	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.944	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.58	Mean of logged Data	2.923
Maximum of Logged Data	3.35	SD of logged Data	0.318
Assuming Lognormal Distribution			
95% H-UCL	33	90% Chebyshev (MVUE) UCL	28.47
95% Chebyshev (MVUE) UCL	32.62	97.5% Chebyshev (MVUE) UCL	38.38
99% Chebyshev (MVUE) UCL	49.68		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	24.69	95% Jackknife UCL	26.98
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	29.08	95% Chebyshev(Mean, Sd) UCL	33.49
97.5% Chebyshev(Mean, Sd) UCL	39.61	99% Chebyshev(Mean, Sd) UCL	51.63

Suggested UCL to Use

95% Student's-t UCL	26.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3.73	Mean	4.808
Maximum	6.75	Median	4.375
SD	1.39	Std. Error of Mean	0.695
Coefficient of Variation	0.289	Skewness	1.31

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.866	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.248	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.443	95% Adjusted-CLT UCL (Chen-1995)	6.437
		95% Modified-t UCL (Johnson-1978)	6.519

Gamma GOF Test

A-D Test Statistic	0.387	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.283	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.43	k star (bias corrected MLE)	4.525
Theta hat (MLE)	0.276	Theta star (bias corrected MLE)	1.063
nu hat (MLE)	139.5	nu star (bias corrected)	36.2
MLE Mean (bias corrected)	4.808	MLE Sd (bias corrected)	2.26
		Approximate Chi Square Value (0.05)	23.43
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.428	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.252	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.316	Mean of logged Data	1.541
Maximum of Logged Data	1.91	SD of logged Data	0.272

Assuming Lognormal Distribution

95% H-UCL	7.388	90% Chebyshev (MVUE) UCL	6.751
95% Chebyshev (MVUE) UCL	7.634	97.5% Chebyshev (MVUE) UCL	8.86
99% Chebyshev (MVUE) UCL	11.27		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.951	95% Jackknife UCL	6.443
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6.893	95% Chebyshev(Mean, Sd) UCL	7.838
97.5% Chebyshev(Mean, Sd) UCL	9.149	99% Chebyshev(Mean, Sd) UCL	11.72

Suggested UCL to Use

95% Student's-t UCL	6.443

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	3/2/2015 12:45		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3.72	Mean	4.208
Maximum	4.99	Median	4.06
SD	0.609	Std. Error of Mean	0.304
Coefficient of Variation	0.145	Skewness	0.77

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.924	95% Adjusted-CLT UCL (Chen-1995)	4.833
		95% Modified-t UCL (Johnson-1978)	4.943
Gamma GOF Test			
A-D Test Statistic	0.421	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.32	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	65.57	k star (bias corrected MLE)	16.56
Theta hat (MLE)	0.0642	Theta star (bias corrected MLE)	0.254
nu hat (MLE)	524.6	nu star (bias corrected)	132.5
MLE Mean (bias corrected)	4.208	MLE Sd (bias corrected)	1.034
		Approximate Chi Square Value (0.05)	106.9
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5.215	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.314	Mean of logged Data	1.429
Maximum of Logged Data	1.607	SD of logged Data	0.142
Assuming Lognormal Distribution			
95% H-UCL	5.097	90% Chebyshev (MVUE) UCL	5.101
95% Chebyshev (MVUE) UCL	5.505	97.5% Chebyshev (MVUE) UCL	6.067
99% Chebyshev (MVUE) UCL	7.171		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	4.708	95% Jackknife UCL	4.924
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.12	95% Chebyshev(Mean, Sd) UCL	5.534
97.5% Chebyshev(Mean, Sd) UCL	6.108	99% Chebyshev(Mean, Sd) UCL	7.235

Suggested UCL to Use

95% Student's-t UCL	4.924

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	103	Mean	146.5
Maximum	223	Median	130
SD	55.55	Std. Error of Mean	27.77
Coefficient of Variation	0.379	Skewness	1.2

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.872	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.256	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	211.9	95% Adjusted-CLT UCL (Chen-1995)	210
		95% Modified-t UCL (Johnson-1978)	214.6

Gamma GOF Test

A-D Test Statistic	0.377	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.293	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	10.15	k star (bias corrected MLE)	2.705
Theta hat (MLE)	14.43	Theta star (bias corrected MLE)	54.15
nu hat (MLE)	81.23	nu star (bias corrected)	21.64
MLE Mean (bias corrected)	146.5	MLE Sd (bias corrected)	89.07
		Approximate Chi Square Value (0.05)	12.07
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	262.7	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.262	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	4.635	Mean of logged Data	4.937
Maximum of Logged Data	5.407	SD of logged Data	0.358

Assuming Lognormal Distribution

95% H-UCL	276.2	90% Chebyshev (MVUE) UCL	223.9
95% Chebyshev (MVUE) UCL	259.2	97.5% Chebyshev (MVUE) UCL	308.1
99% Chebyshev (MVUE) UCL	404.1		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	192.2	95% Jackknife UCL	211.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	229.8	95% Chebyshev(Mean, Sd) UCL	267.6
97.5% Chebyshev(Mean, Sd) UCL	320	99% Chebyshev(Mean, Sd) UCL	422.9

Suggested UCL to Use

95% Student's-t UCL	211.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/23/2015 9:17		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	1
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.038	Minimum Non-Detect	0.02
Maximum Detect	0.04	Maximum Non-Detect	0.02
Variance Detects	2.00E-06	Percent Non-Detects	33.33%
Mean Detects	0.039	SD Detects	0.00141
Median Detects	0.039	CV Detects	0.0363
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-3.245	SD of Logged Detects	0.0363

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0327	Standard Error of Mean	0.00734
SD	0.00899	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0541	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0447	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0547	95% KM Chebyshev UCL	0.0647
97.5% KM Chebyshev UCL	0.0785	99% KM Chebyshev UCL	0.106

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1521	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.56E-05	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	6083	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	13.19	nu hat (KM)	79.15
		Adjusted Level of Significance (β)	0.00136
Approximate Chi Square Value (79.15, α)	59.66	Adjusted Chi Square Value (79.15, β)	46.69
95% Gamma Approximate KM-UCL (use when n>=50)	0.0433	95% Gamma Adjusted KM-UCL (use when n<50)	0.0554

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0376	Mean in Log Scale	-3.283
SD in Original Scale	0.00268	SD in Log Scale	0.072
95% t UCL (assumes normality of ROS data)	0.0421	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	N/A		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0293	Mean in Log Scale	-3.698
SD in Original Scale	0.0168	SD in Log Scale	0.786
95% t UCL (Assumes normality)	0.0576	95% H-Stat UCL	10.03

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Pb in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:19
From File	WorkSheet.xls
Full Precision	OFF
ConfidenceCoefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	231	Mean	299.5
Maximum	367	Median	300
SD	64.01	Std. Error of Mean	32
Coefficient of Variation	0.214	Skewness	-0.0237

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.923	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.231	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	374.8	95% Adjusted-CLT UCL (Chen-1995)	351.7
		95% Modified-t UCL (Johnson-1978)	374.8

Gamma GOF Test		
A-D Test Statistic	0.334	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.27	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	28.67	k star (bias corrected MLE)	7.335
Theta hat (MLE)	10.45	Theta star (bias corrected MLE)	40.83
nu hat (MLE)	229.4	nu star (bias corrected)	58.68
MLE Mean (bias corrected)	299.5	MLE Sd (bias corrected)	110.6
		Approximate Chi Square Value (0.05)	42.07
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	417.8	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.242	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	5.442	Mean of logged Data	5.685
Maximum of Logged Data	5.905	SD of logged Data	0.217

Assuming Lognormal Distribution			
95% H-UCL	413.1	90% Chebyshev (MVUE) UCL	396.9
95% Chebyshev (MVUE) UCL	441	97.5% Chebyshev (MVUE) UCL	502.2
99% Chebyshev (MVUE) UCL	622.4		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	352.1	95% Jackknife UCL	374.8
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	395.5	95% Chebyshev(Mean, Sd) UCL	439
97.5% Chebyshev(Mean, Sd) UCL	499.4	99% Chebyshev(Mean, Sd) UCL	617.9

Suggested UCL to Use

95% Student's-t UCL	374.8

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Mn in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	3010	Mean	4348
Maximum	6900	Median	3740
SD	1736	Std. Error of Mean	868.1
Coefficient of Variation	0.399	Skewness	1.757

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.385	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6390	95% Adjusted-CLT UCL (Chen-1995)	6590
		95% Modified-t UCL (Johnson-1978)	6517

Gamma GOF Test

A-D Test Statistic	0.537	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.385	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.836	k star (bias corrected MLE)	2.626
Theta hat (MLE)	442	Theta star (bias corrected MLE)	1656
nu hat (MLE)	78.69	nu star (bias corrected)	21.01
MLE Mean (bias corrected)	4348	MLE Sd (bias corrected)	2683
		Approximate Chi Square Value (0.05)	11.6
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7876	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.356	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.01	Mean of logged Data	8.326
Maximum of Logged Data	8.839	SD of logged Data	0.357

Assuming Lognormal Distribution

95% H-UCL	8164	90% Chebyshev (MVUE) UCL	6628
95% Chebyshev (MVUE) UCL	7669	97.5% Chebyshev (MVUE) UCL	9114
99% Chebyshev (MVUE) UCL	11953		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5775	95% Jackknife UCL	6390
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	6952	95% Chebyshev(Mean, Sd) UCL	8131
97.5% Chebyshev(Mean, Sd) UCL	9769	99% Chebyshev(Mean, Sd) UCL	12985

Suggested UCL to Use

95% Student's-t UCL	6390

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 14:20		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7.27	Mean	9.415
Maximum	13.1	Median	8.645
SD	2.567	Std. Error of Mean	1.283
Coefficient of Variation	0.273	Skewness	1.512

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.44	95% Adjusted-CLT UCL (Chen-1995)	12.56
		95% Modified-t UCL (Johnson-1978)	12.6
Gamma GOF Test			
A-D Test Statistic	0.365	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.282	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	19.86	k star (bias corrected MLE)	5.132
Theta hat (MLE)	0.474	Theta star (bias corrected MLE)	1.834
nu hat (MLE)	158.9	nu star (bias corrected)	41.06
MLE Mean (bias corrected)	9.415	MLE Sd (bias corrected)	4.156
		Approximate Chi Square Value (0.05)	27.37
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	14.12	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.265	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.984	Mean of logged Data	2.217
Maximum of Logged Data	2.573	SD of logged Data	0.254
Assuming Lognormal Distribution			
95% H-UCL	13.93	90% Chebyshev (MVUE) UCL	12.97
95% Chebyshev (MVUE) UCL	14.58	97.5% Chebyshev (MVUE) UCL	16.83
99% Chebyshev (MVUE) UCL	21.23		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	11.53	95% Jackknife UCL	12.44
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	13.26	95% Chebyshev(Mean, Sd) UCL	15.01
97.5% Chebyshev(Mean, Sd) UCL	17.43	99% Chebyshev(Mean, Sd) UCL	22.18

Suggested UCL to Use

95% Student's-t UCL	12.44

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	1.06	Minimum Non-Detect	0.498
Maximum Detect	1.4	Maximum Non-Detect	1.02
Variance Detects	0.0578	Percent Non-Detects	50%
Mean Detects	1.23	SD Detects	0.24
Median Detects	1.23	CV Detects	0.195
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.197	SD of Logged Detects	0.197

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.864	Standard Error of Mean	0.272
SD	0.385	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.505	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.312	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.681	95% KM Chebyshev UCL	2.051
97.5% KM Chebyshev UCL	2.565	99% KM Chebyshev UCL	3.574

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	52.01	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0236	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	208.1	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	5.03	nu hat (KM)	40.24
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (40.24, α)	26.71	Adjusted Chi Square Value (40.24, β)	20.87
95% Gamma Approximate KM-UCL (use when n>=50)	1.302	95% Gamma Adjusted KM-UCL (use when n<50)	1.666

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.914	Mean in Log Scale	-0.159
SD in Original Scale	0.391	SD in Log Scale	0.426
95% t UCL (assumes normality of ROS data)	1.373	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	2.103		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.805	Mean in Log Scale	-0.417
SD in Original Scale	0.521	SD in Log Scale	0.776
95% t UCL (Assumes normality)	1.418	95% H-Stat UCL	9.42

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.505	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 14:20		
From File	WorkSheet.xls		
Full Precision	OFF		
ConfidenceCoefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.724	Mean	1.078
Maximum	1.37	Median	1.109
SD	0.297	Std. Error of Mean	0.148
Coefficient of Variation	0.275	Skewness	-0.372

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.241	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.427	95% Adjusted-CLT UCL (Chen-1995)	1.293
		95% Modified-t UCL (Johnson-1978)	1.423
Gamma GOF Test			
A-D Test Statistic	0.309	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.278	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	16.43	k star (bias corrected MLE)	4.274
Theta hat (MLE)	0.0656	Theta star (bias corrected MLE)	0.252
nu hat (MLE)	131.4	nu star (bias corrected)	34.19
MLE Mean (bias corrected)	1.078	MLE Sd (bias corrected)	0.521
		Approximate Chi Square Value (0.05)	21.82
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.689	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.929	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.323	Mean of logged Data	0.0444
Maximum of Logged Data	0.315	SD of logged Data	0.292
Assuming Lognormal Distribution			
95% H-UCL	1.733	90% Chebyshev (MVUE) UCL	1.548
95% Chebyshev (MVUE) UCL	1.761	97.5% Chebyshev (MVUE) UCL	2.056
99% Chebyshev (MVUE) UCL	2.636		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.322	95% Jackknife UCL	1.427
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.523	95% Chebyshev(Mean, Sd) UCL	1.725
97.5% Chebyshev(Mean, Sd) UCL	2.005	99% Chebyshev(Mean, Sd) UCL	2.555

Suggested UCL to Use

95% Student's-t UCL	1.427

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Zn in sediment of the Animas River at sampling location A75D below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1030	Mean	1738
Maximum	2910	Median	1505
SD	884.1	Std. Error of Mean	442
Coefficient of Variation	0.509	Skewness	0.946

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2778	95% Adjusted-CLT UCL (Chen-1995)	2688
		95% Modified-t UCL (Johnson-1978)	2813
Gamma GOF Test			
A-D Test Statistic	0.39	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.311	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	5.458	k star (bias corrected MLE)	1.531
Theta hat (MLE)	318.3	Theta star (bias corrected MLE)	1135
nu hat (MLE)	43.66	nu star (bias corrected)	12.25
MLE Mean (bias corrected)	1738	MLE Sd (bias corrected)	1404
		Approximate Chi Square Value (0.05)	5.392
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3947	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	6.937	Mean of logged Data	7.366
Maximum of Logged Data	7.976	SD of logged Data	0.497
Assuming Lognormal Distribution			
95% H-UCL	5086	90% Chebyshev (MVUE) UCL	2999
95% Chebyshev (MVUE) UCL	3572	97.5% Chebyshev (MVUE) UCL	4369
99% Chebyshev (MVUE) UCL	5934		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2465	95% Jackknife UCL	2778
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3064	95% Chebyshev(Mean, Sd) UCL	3664
97.5% Chebyshev(Mean, Sd) UCL	4498	99% Chebyshev(Mean, Sd) UCL	6136

Suggested UCL to Use

95% Student's-t UCL	2778

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Al in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7360	Mean	20025
Maximum	37400	Median	17670
SD	14820	Std. Error of Mean	7410
Coefficient of Variation	0.74	Skewness	0.385

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.291	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	37463	95% Adjusted-CLT UCL (Chen-1995)	33735
		95% Modified-t UCL (Johnson-1978)	37700
Gamma GOF Test			
A-D Test Statistic	0.477	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.325	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.195	k star (bias corrected MLE)	0.715
Theta hat (MLE)	9122	Theta star (bias corrected MLE)	27988
nu hat (MLE)	17.56	nu star (bias corrected)	5.724
MLE Mean (bias corrected)	20025	MLE Sd (bias corrected)	23674
		Approximate Chi Square Value (0.05)	1.5
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	76391	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.289	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	8.904	Mean of logged Data	9.66
Maximum of Logged Data	10.53	SD of logged Data	0.833
Assuming Lognormal Distribution			
95% H-UCL	330609	90% Chebyshev (MVUE) UCL	43920
95% Chebyshev (MVUE) UCL	54715	97.5% Chebyshev (MVUE) UCL	69699
99% Chebyshev (MVUE) UCL	99131		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	32213	95% Jackknife UCL	37463
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	42254	95% Chebyshev(Mean, Sd) UCL	52323
97.5% Chebyshev(Mean, Sd) UCL	66299	99% Chebyshev(Mean, Sd) UCL	93751

Suggested UCL to Use

95% Student's-t UCL	37463

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for As in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:37
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	15.9	Mean	21.93
Maximum	29.7	Median	21.05
SD	6.96	Std. Error of Mean	3.48
Coefficient of Variation	0.317	Skewness	0.25

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.849	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.295	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.11	95% Adjusted-CLT UCL (Chen-1995)	28.11
		95% Modified-t UCL (Johnson-1978)	30.19
Gamma GOF Test			
A-D Test Statistic	0.494	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.329	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	13.17	k star (bias corrected MLE)	3.459
Theta hat (MLE)	1.665	Theta star (bias corrected MLE)	6.339
nu hat (MLE)	105.4	nu star (bias corrected)	27.67
MLE Mean (bias corrected)	21.93	MLE Sd (bias corrected)	11.79
		Approximate Chi Square Value (0.05)	16.67
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	36.39	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.295	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.766	Mean of logged Data	3.049
Maximum of Logged Data	3.391	SD of logged Data	0.321
Assuming Lognormal Distribution			
95% H-UCL	37.68	90% Chebyshev (MVUE) UCL	32.39
95% Chebyshev (MVUE) UCL	37.13	97.5% Chebyshev (MVUE) UCL	43.71
99% Chebyshev (MVUE) UCL	56.64		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	27.65	95% Jackknife UCL	30.11
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	32.37	95% Chebyshev(Mean, Sd) UCL	37.09
97.5% Chebyshev(Mean, Sd) UCL	43.66	99% Chebyshev(Mean, Sd) UCL	56.55

Suggested UCL to Use

95% Student's-t UCL	30.11

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Be in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options			
Date/Time of Computation	2/18/2015 14:37		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	3.51	Minimum Non-Detect	1.98
Maximum Detect	4.85	Maximum Non-Detect	1.99
Variance Detects	0.898	Percent Non-Detects	50%
Mean Detects	4.18	SD Detects	0.948
Median Detects	4.18	CV Detects	0.227
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.417	SD of Logged Detects	0.229

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.08	Standard Error of Mean	0.847
SD	1.198	95% KM (BCA) UCL	N/A
95% KM (t) UCL	5.073	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	4.473	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	5.621	95% KM Chebyshev UCL	6.772
97.5% KM Chebyshev UCL	8.369	99% KM Chebyshev UCL	11.51

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	38.59	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.108	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	154.3	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.613	nu hat (KM)	52.91
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (52.91, α)	37.2	Adjusted Chi Square Value (52.91, β)	30.15
95% Gamma Approximate KM-UCL (use when n>=50)	4.381	95% Gamma Adjusted KM-UCL (use when n<50)	5.405

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.992	Mean in Log Scale	1.004
SD in Original Scale	1.477	SD in Log Scale	0.496
95% t UCL (assumes normality of ROS data)	4.73	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	8.731		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.586	Mean in Log Scale	0.705
SD in Original Scale	1.92	SD in Log Scale	0.833
95% t UCL (Assumes normality)	4.845	95% H-Stat UCL	42.74

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	5.073	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Cd in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.46	Mean	10.07
Maximum	18.6	Median	9.615
SD	7.763	Std. Error of Mean	3.881
Coefficient of Variation	0.771	Skewness	0.158

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	19.21	95% Adjusted-CLT UCL (Chen-1995)	16.78
		95% Modified-t UCL (Johnson-1978)	19.26
Gamma GOF Test			
A-D Test Statistic	0.355	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.661	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.281	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.812	k star (bias corrected MLE)	0.62
Theta hat (MLE)	5.558	Theta star (bias corrected MLE)	16.25
nu hat (MLE)	14.5	nu star (bias corrected)	4.958
MLE Mean (bias corrected)	10.07	MLE Sd (bias corrected)	12.79
		Approximate Chi Square Value (0.05)	1.133
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	44.08	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0.9	Mean of logged Data	2.009
Maximum of Logged Data	2.923	SD of logged Data	0.956
Assuming Lognormal Distribution			
95% H-UCL	401.9	90% Chebyshev (MVUE) UCL	24.09
95% Chebyshev (MVUE) UCL	30.34	97.5% Chebyshev (MVUE) UCL	39.01
99% Chebyshev (MVUE) UCL	56.05		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	16.46	95% Jackknife UCL	19.21
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	21.72	95% Chebyshev(Mean, Sd) UCL	26.99
97.5% Chebyshev(Mean, Sd) UCL	34.31	99% Chebyshev(Mean, Sd) UCL	48.69

Suggested UCL to Use

95% Student's-t UCL	19.21

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cu in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	92	Mean	191
Maximum	357	Median	157.5
SD	119.8	Std. Error of Mean	59.89
Coefficient of Variation	0.627	Skewness	1.234

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.893	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.234	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	331.9	95% Adjusted-CLT UCL (Chen-1995)	329
		95% Modified-t UCL (Johnson-1978)	338.1

Gamma GOF Test

A-D Test Statistic	0.295	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.26	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.713	k star (bias corrected MLE)	1.095
Theta hat (MLE)	51.44	Theta star (bias corrected MLE)	174.4
nu hat (MLE)	29.7	nu star (bias corrected)	8.759
MLE Mean (bias corrected)	191	MLE Sd (bias corrected)	182.5
		Approximate Chi Square Value (0.05)	3.182
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	525.7	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.223	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.522	Mean of logged Data	5.112
Maximum of Logged Data	5.878	SD of logged Data	0.604

Assuming Lognormal Distribution

95% H-UCL	873	90% Chebyshev (MVUE) UCL	356.9
95% Chebyshev (MVUE) UCL	432.7	97.5% Chebyshev (MVUE) UCL	537.8
99% Chebyshev (MVUE) UCL	744.4		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	289.5	95% Jackknife UCL	331.9
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	370.7	95% Chebyshev(Mean, Sd) UCL	452.1
97.5% Chebyshev(Mean, Sd) UCL	565	99% Chebyshev(Mean, Sd) UCL	786.9

Suggested UCL to Use

95% Student's-t UCL	331.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Cr in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	3/2/2015 12:45
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	4.28	Mean	5.403
Maximum	7.38	Median	4.975
SD	1.372	Std. Error of Mean	0.686
Coefficient of Variation	0.254	Skewness	1.554

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.864	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.306	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.017	95% Adjusted-CLT UCL (Chen-1995)	7.1
		95% Modified-t UCL (Johnson-1978)	7.106

Gamma GOF Test		
A-D Test Statistic	0.387	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.291	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	22.87	k star (bias corrected MLE)	5.883
Theta hat (MLE)	0.236	Theta star (bias corrected MLE)	0.918
nu hat (MLE)	182.9	nu star (bias corrected)	47.07
MLE Mean (bias corrected)	5.403	MLE Sd (bias corrected)	2.227
		Approximate Chi Square Value (0.05)	32.32
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	7.867	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.906	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.274	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	1.454	Mean of logged Data	1.665
Maximum of Logged Data	1.999	SD of logged Data	0.237

Assuming Lognormal Distribution			
95% H-UCL	7.721	90% Chebyshev (MVUE) UCL	7.304
95% Chebyshev (MVUE) UCL	8.168	97.5% Chebyshev (MVUE) UCL	9.368
99% Chebyshev (MVUE) UCL	11.72		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	6.531	95% Jackknife UCL	7.017
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	7.46	95% Chebyshev(Mean, Sd) UCL	8.393
97.5% Chebyshev(Mean, Sd) UCL	9.686	99% Chebyshev(Mean, Sd) UCL	12.23

Suggested UCL to Use

95% Student's-t UCL	7.017

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hg in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/23/2015 9:20
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.02	Mean	0.041
Maximum	0.06	Median	0.043
SD	0.0201	Std. Error of Mean	0.0116
Coefficient of Variation	0.49	Skewness	-0.444

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test		
Shapiro Wilk Test Statistic	0.993	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	Lilliefors GOF Test
5% Lilliefors Critical Value	0.512	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0748	95% Adjusted-CLT UCL (Chen-1995)	0.0569
		95% Modified-t UCL (Johnson-1978)	0.0743

Gamma GOF Test
Not Enough Data to Perform GOF Test

Gamma Statistics			
k hat (MLE)	5.344	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00767	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	32.06	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.268	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.512	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	-3.912	Mean of logged Data	-3.291
Maximum of Logged Data	-2.813	SD of logged Data	0.563

Assuming Lognormal Distribution			
95% H-UCL	0.806	90% Chebyshev (MVUE) UCL	0.08
95% Chebyshev (MVUE) UCL	0.0976	97.5% Chebyshev (MVUE) UCL	0.122
99% Chebyshev (MVUE) UCL	0.17		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	0.0601	95% Jackknife UCL	0.0748
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.0758	95% Chebyshev(Mean, Sd) UCL	0.0915
97.5% Chebyshev(Mean, Sd) UCL	0.113	99% Chebyshev(Mean, Sd) UCL	0.156

Suggested UCL to Use

95% Student's-t UCL	0.0748

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL calculations for Pb in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	244	Mean	299.5
Maximum	378	Median	288
SD	65.08	Std. Error of Mean	32.54
Coefficient of Variation	0.217	Skewness	0.482

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.876	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.286	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	376.1	95% Adjusted-CLT UCL (Chen-1995)	361.4
		95% Modified-t UCL (Johnson-1978)	377.4

Gamma GOF Test

A-D Test Statistic	0.426	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.321	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	28.76	k star (bias corrected MLE)	7.356
Theta hat (MLE)	10.42	Theta star (bias corrected MLE)	40.72
nu hat (MLE)	230.1	nu star (bias corrected)	58.85
MLE Mean (bias corrected)	299.5	MLE Sd (bias corrected)	110.4
		Approximate Chi Square Value (0.05)	42.21
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	417.6	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.287	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.497	Mean of logged Data	5.685
Maximum of Logged Data	5.935	SD of logged Data	0.215

Assuming Lognormal Distribution

95% H-UCL	411.2	90% Chebyshev (MVUE) UCL	395.7
95% Chebyshev (MVUE) UCL	439.3	97.5% Chebyshev (MVUE) UCL	499.9
99% Chebyshev (MVUE) UCL	618.8		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	353	95% Jackknife UCL	376.1
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	397.1	95% Chebyshev(Mean, Sd) UCL	441.3
97.5% Chebyshev(Mean, Sd) UCL	502.7	99% Chebyshev(Mean, Sd) UCL	623.3

Suggested UCL to Use

95% Student's-t UCL	376.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Mn in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2130	Mean	7425
Maximum	13100	Median	7235
SD	5216	Std. Error of Mean	2608
Coefficient of Variation	0.703	Skewness	0.104

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.246	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	13563	95% Adjusted-CLT UCL (Chen-1995)	11860
		95% Modified-t UCL (Johnson-1978)	13586
Gamma GOF Test			
A-D Test Statistic	0.336	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.279	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.235	k star (bias corrected MLE)	0.725
Theta hat (MLE)	3323	Theta star (bias corrected MLE)	10237
nu hat (MLE)	17.88	nu star (bias corrected)	5.803
MLE Mean (bias corrected)	7425	MLE Sd (bias corrected)	8718
		Approximate Chi Square Value (0.05)	1.54
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	27980	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.255	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.664	Mean of logged Data	8.672
Maximum of Logged Data	9.48	SD of logged Data	0.849
Assuming Lognormal Distribution			
95% H-UCL	138250	90% Chebyshev (MVUE) UCL	16668
95% Chebyshev (MVUE) UCL	20798	97.5% Chebyshev (MVUE) UCL	26529
99% Chebyshev (MVUE) UCL	37787		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	11715	95% Jackknife UCL	13563
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15250	95% Chebyshev(Mean, Sd) UCL	18794
97.5% Chebyshev(Mean, Sd) UCL	23713	99% Chebyshev(Mean, Sd) UCL	33377

Suggested UCL to Use

95% Student's-t UCL	13563

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ni in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	7.36	Mean	18.27
Maximum	31.6	Median	17.05
SD	10.78	Std. Error of Mean	5.391
Coefficient of Variation	0.59	Skewness	0.475

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.962	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.216	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.95	95% Adjusted-CLT UCL (Chen-1995)	28.5
		95% Modified-t UCL (Johnson-1978)	31.16

Gamma GOF Test

A-D Test Statistic	0.232	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.207	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics

k hat (MLE)	3.568	k star (bias corrected MLE)	1.059
Theta hat (MLE)	5.119	Theta star (bias corrected MLE)	17.25
nu hat (MLE)	28.55	nu star (bias corrected)	8.47
MLE Mean (bias corrected)	18.27	MLE Sd (bias corrected)	17.75
		Approximate Chi Square Value (0.05)	3.01
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	51.4	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.197	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics

Minimum of Logged Data	1.996	Mean of logged Data	2.758
Maximum of Logged Data	3.453	SD of logged Data	0.644

Assuming Lognormal Distribution

95% H-UCL	102.2	90% Chebyshev (MVUE) UCL	35.53
95% Chebyshev (MVUE) UCL	43.31	97.5% Chebyshev (MVUE) UCL	54.12
99% Chebyshev (MVUE) UCL	75.34		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	27.13	95% Jackknife UCL	30.95
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	34.44	95% Chebyshev(Mean, Sd) UCL	41.76
97.5% Chebyshev(Mean, Sd) UCL	51.93	99% Chebyshev(Mean, Sd) UCL	71.9

Suggested UCL to Use

95% Student's-t UCL	30.95

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1.02	Mean	1.285
Maximum	1.71	Median	1.205
SD	0.314	Std. Error of Mean	0.157
Coefficient of Variation	0.244	Skewness	1.074

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.903	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.243	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.654	95% Adjusted-CLT UCL (Chen-1995)	1.633
		95% Modified-t UCL (Johnson-1978)	1.668

Gamma GOF Test

A-D Test Statistic	0.33	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.275	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	23.81	k star (bias corrected MLE)	6.118
Theta hat (MLE)	0.054	Theta star (bias corrected MLE)	0.21
nu hat (MLE)	190.5	nu star (bias corrected)	48.95
MLE Mean (bias corrected)	1.285	MLE Sd (bias corrected)	0.52
		Approximate Chi Square Value (0.05)	33.89
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.856	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.243	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0198	Mean of logged Data	0.23
Maximum of Logged Data	0.536	SD of logged Data	0.234

Assuming Lognormal Distribution

95% H-UCL	1.829	90% Chebyshev (MVUE) UCL	1.733
95% Chebyshev (MVUE) UCL	1.937	97.5% Chebyshev (MVUE) UCL	2.219
99% Chebyshev (MVUE) UCL	2.774		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.543	95% Jackknife UCL	1.654
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.755	95% Chebyshev(Mean, Sd) UCL	1.968
97.5% Chebyshev(Mean, Sd) UCL	2.264	99% Chebyshev(Mean, Sd) UCL	2.845

Suggested UCL to Use

95% Student's-t UCL	1.654

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Se in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/18/2015 14:38
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	1.16	Minimum Non-Detect	0.496
Maximum Detect	3.1	Maximum Non-Detect	0.997
Variance Detects	1.882	Percent Non-Detects	50%
Mean Detects	2.13	SD Detects	1.372
Median Detects	2.13	CV Detects	0.644
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.64	SD of Logged Detects	0.695

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.313	Standard Error of Mean	0.754
SD	1.067	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.088	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	2.554	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3.576	95% KM Chebyshev UCL	4.601
97.5% KM Chebyshev UCL	6.024	99% KM Chebyshev UCL	8.818

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	4.462	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.477	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	17.85	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.515	nu hat (KM)	12.12
		Adjusted Level of Significance (β)	0.00498
Approximate Chi Square Value (12.12, α)	5.306	Adjusted Chi Square Value (12.12, β)	3.132
95% Gamma Approximate KM-UCL (use when n>=50)	2.999	95% Gamma Adjusted KM-UCL (use when n<50)	5.08

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.142	Mean in Log Scale	-0.618
SD in Original Scale	1.389	SD in Log Scale	1.507
95% t UCL (assumes normality of ROS data)	2.776	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	9381		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.252	Mean in Log Scale	-0.203
SD in Original Scale	1.291	SD in Log Scale	1.09
95% t UCL (Assumes normality)	2.771	95% H-Stat UCL	141.3

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.088	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for Ag in sediment of the Animas River at Bakers Bridge below mainstem Mineral Creek

User Selected Options	
Date/Time of Computation	2/19/2015 11:31
From File	WorkSheet_e.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	1700	Mean	4620
Maximum	8670	Median	4055
SD	3335	Std. Error of Mean	1668
Coefficient of Variation	0.722	Skewness	0.502

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test			
Shapiro Wilk Test Statistic	0.891	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.277	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	8544	95% Adjusted-CLT UCL (Chen-1995)	7810
		95% Modified-t UCL (Johnson-1978)	8614
Gamma GOF Test			
A-D Test Statistic	0.397	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.304	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.371	k star (bias corrected MLE)	0.759
Theta hat (MLE)	1949	Theta star (bias corrected MLE)	6084
nu hat (MLE)	18.97	nu star (bias corrected)	6.075
MLE Mean (bias corrected)	4620	MLE Sd (bias corrected)	5302
		Approximate Chi Square Value (0.05)	1.678
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	16724	95% Adjusted Gamma UCL (use when n<50)	N/A
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.264	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.438	Mean of logged Data	8.213
Maximum of Logged Data	9.068	SD of logged Data	0.796
Assuming Lognormal Distribution			
95% H-UCL	60185	90% Chebyshev (MVUE) UCL	9897
95% Chebyshev (MVUE) UCL	12284	97.5% Chebyshev (MVUE) UCL	15597
99% Chebyshev (MVUE) UCL	22105		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	7363	95% Jackknife UCL	8544
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	9623	95% Chebyshev(Mean, Sd) UCL	11889
97.5% Chebyshev(Mean, Sd) UCL	15034	99% Chebyshev(Mean, Sd) UCL	21212

Suggested UCL to Use

95% Student's-t UCL	8544

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Al in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operation:	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	3
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	20.9	Minimum Non-Detect	20
Maximum Detect	6170	Maximum Non-Detect	20
Variance Detects	4686062	Percent Non-Detects	27.27%
Mean Detects	1259	SD Detects	2165
Median Detects	260	CV Detects	1.72
Skewness Detects	2.123	Kurtosis Detects	4.375
Mean of Logged Detects	5.552	SD of Logged Detects	2.069

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.661	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.357	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	921	Standard Error of Mean	584.3
SD	1813	95% KM (BCA) UCL	2035
95% KM (t) UCL	1980	95% KM (Percentile Bootstrap) UCL	1989
95% KM (z) UCL	1882	95% KM Bootstrap t UCL	7837
90% KM Chebyshev UCL	2674	95% KM Chebyshev UCL	3468
97.5% KM Chebyshev UCL	4570	99% KM Chebyshev UCL	6735

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.458	Anderson-Darling GOF Test	
5% A-D Critical Value	0.778	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.208	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.413	k star (bias corrected MLE)	0.341
Theta hat (MLE)	3050	Theta star (bias corrected MLE)	3689
nu hat (MLE)	6.604	nu star (bias corrected)	5.461
MLE Mean (bias corrected)	1259	MLE Sd (bias corrected)	2155

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.258	nu hat (KM)	5.679
Approximate Chi Square Value (5.68, α)	1.478	Adjusted Chi Square Value (5.68, β)	1.159
95% Gamma Approximate KM-UCL (use when n>=50)	3539	95% Gamma Adjusted KM-UCL (use when n<50)	4514

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	915.6
Maximum	6170	Median	42.8
SD	1904	CV	2.08
k hat (MLE)	0.185	k star (bias corrected MLE)	0.195
Theta hat (MLE)	4962	Theta star (bias corrected MLE)	4700
nu hat (MLE)	4.06	nu star (bias corrected)	4.286
MLE Mean (bias corrected)	915.6	MLE Sd (bias corrected)	2074
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.29, α)	0.838	Adjusted Chi Square Value (4.29, β)	0.623
95% Gamma Approximate UCL (use when n>=50)	4684	95% Gamma Adjusted UCL (use when n<50)	6297

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.182	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	916.1	Mean in Log Scale	4.109
SD in Original Scale	1904	SD in Log Scale	3.059
95% t UCL (assumes normality of ROS data)	1957	95% Percentile Bootstrap UCL	1966
95% BCA Bootstrap UCL	2394	95% Bootstrap t UCL	7860
95% H-UCL (Log ROS)	10504481		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.855	95% H-UCL (KM -Log)	25280
KM SD (logged)	2.005	95% Critical H Value (KM-Log)	5.165
KM Standard Error of Mean (logged)	0.646		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	918.3	Mean in Log Scale	4.666
SD in Original Scale	1903	SD in Log Scale	2.302
95% t UCL (Assumes normality)	1958	95% H-Stat UCL	106111

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	3468	95% GROS Adjusted Gamma UCL	6297
95% Adjusted Gamma KM-UCL	4514		

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cd in pore water from the Animas River above the confluence with mainstem Cement Cree

User Selected Options			
Date/Time of Computation	3/5/2015 14:28		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
General Statistics			
Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.279	Mean	23.58
Maximum	106.5	Median	1.67
SD	40.29	Std. Error of Mean	12.15
Coefficient of Variation	1.708	Skewness	1.752
Normal GOF Test			
Shapiro Wilk Test Statistic	0.625	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.33	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	45.6	95% Adjusted-CLT UCL (Chen-1995)	50.42
		95% Modified-t UCL (Johnson-1978)	46.67
Gamma GOF Test			
A-D Test Statistic	0.806	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.809	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.245	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.274	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.357	k star (bias corrected MLE)	0.32
Theta hat (MLE)	66.14	Theta star (bias corrected MLE)	73.72
nu hat (MLE)	7.844	nu star (bias corrected)	7.038
MLE Mean (bias corrected)	23.58	MLE Sd (bias corrected)	41.7
		Approximate Chi Square Value (0.05)	2.192
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	1.778
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	75.74	95% Adjusted Gamma UCL (use when n<50)	93.35
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.891	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.18	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.267	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-1.277	Mean of logged Data	1.28
Maximum of Logged Data	4.668	SD of logged Data	2.232
Assuming Lognormal Distribution			
95% H-UCL	2400	90% Chebyshev (MVUE) UCL	78.75
95% Chebyshev (MVUE) UCL	102.9	97.5% Chebyshev (MVUE) UCL	136.4
99% Chebyshev (MVUE) UCL	202.2		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	43.56	95% Jackknife UCL	45.6
95% Standard Bootstrap UCL	42.7	95% Bootstrap-t UCL	110.9
95% Hall's Bootstrap UCL	147.4	95% Percentile Bootstrap UCL	42.46
95% BCA Bootstrap UCL	50.92		
90% Chebyshev(Mean, Sd) UCL	60.02	95% Chebyshev(Mean, Sd) UCL	76.53
97.5% Chebyshev(Mean, Sd) UCL	99.44	99% Chebyshev(Mean, Sd) UCL	144.4
Suggested UCL to Use			
95% Adjusted Gamma UCL	93.35		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Cu in pore water from the Animas River above the confluence with mainstem Cement Cree

User Selected Options	
Date/Time of Computation	3/5/2015 14:28
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	1.27	Mean	223.9
Maximum	2250	Median	3.46
SD	672.7	Std. Error of Mean	202.8
Coefficient of Variation	3.004	Skewness	3.304

Normal GOF Test

Shapiro Wilk Test Statistic	0.379	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.485	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	591.5	95% Adjusted-CLT UCL (Chen-1995)	773.4
		95% Modified-t UCL (Johnson-1978)	625.2

Gamma GOF Test

A-D Test Statistic	1.64	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.848	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.325	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.28	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	0.231	k star (bias corrected MLE)	0.229
Theta hat (MLE)	968.9	Theta star (bias corrected MLE)	979.2
nu hat (MLE)	5.084	nu star (bias corrected)	5.031
MLE Mean (bias corrected)	223.9	MLE Sd (bias corrected)	468.2
		Approximate Chi Square Value (0.05)	1.167
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	0.895

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	965.7	95% Adjusted Gamma UCL (use when n<50)	1259

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.82	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.85	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.279	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.267	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	0.239	Mean of logged Data	2.299
Maximum of Logged Data	7.719	SD of logged Data	2.412

Assuming Lognormal Distribution

95% H-UCL	19254	90% Chebyshev (MVUE) UCL	302.3
95% Chebyshev (MVUE) UCL	396.6	97.5% Chebyshev (MVUE) UCL	527.6
99% Chebyshev (MVUE) UCL	784.8		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	557.5	95% Jackknife UCL	591.5
95% Standard Bootstrap UCL	551.4	95% Bootstrap-t UCL	7505
95% Hall's Bootstrap UCL	5240	95% Percentile Bootstrap UCL	628.4
95% BCA Bootstrap UCL	833.1		
90% Chebyshev(Mean, Sd) UCL	832.4	95% Chebyshev(Mean, Sd) UCL	1108
97.5% Chebyshev(Mean, Sd) UCL	1491	99% Chebyshev(Mean, Sd) UCL	2242

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	2242

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Pb in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	8
Number of Detects	6	Number of Non-Detects	5
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.123	Minimum Non-Detect	0.1
Maximum Detect	65.6	Maximum Non-Detect	0.5
Variance Detects	673.6	Percent Non-Detects	45.45%
Mean Detects	13.66	SD Detects	25.95
Median Detects	1.29	CV Detects	1.9
Skewness Detects	2.255	Kurtosis Detects	5.155
Mean of Logged Detects	0.579	SD of Logged Detects	2.418

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.626	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.34	Lilliefors GOF Test
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	7.499	Standard Error of Mean	6.194
SD	18.75	95% KM (BCA) UCL	18.37
95% KM (t) UCL	18.73	95% KM (Percentile Bootstrap) UCL	19.22
95% KM (z) UCL	17.69	95% KM Bootstrap t UCL	194.9
90% KM Chebyshev UCL	26.08	95% KM Chebyshev UCL	34.5
97.5% KM Chebyshev UCL	46.18	99% KM Chebyshev UCL	69.13

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.446	Anderson-Darling GOF Test
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.262	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.355	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.333	k star (bias corrected MLE)	0.278
Theta hat (MLE)	41.01	Theta star (bias corrected MLE)	49.2
nu hat (MLE)	3.997	nu star (bias corrected)	3.332
MLE Mean (bias corrected)	13.66	MLE Sd (bias corrected)	25.92

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.16	nu hat (KM)	3.518
Approximate Chi Square Value (3.52, α)	0.541	Adjusted Chi Square Value (3.52, β)	0.388
95% Gamma Approximate KM-UCL (use when n>=50)	48.76	95% Gamma Adjusted KM-UCL (use when n<50)	68.03

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.455
Maximum	65.6	Median	0.123
SD	19.69	CV	2.641
k hat (MLE)	0.195	k star (bias corrected MLE)	0.203
Theta hat (MLE)	38.21	Theta star (bias corrected MLE)	36.82
nu hat (MLE)	4.293	nu star (bias corrected)	4.455
MLE Mean (bias corrected)	7.455	MLE Sd (bias corrected)	16.57
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.46, α)	0.909	Adjusted Chi Square Value (4.46, β)	0.682
95% Gamma Approximate UCL (use when n>=50)	36.53	95% Gamma Adjusted UCL (use when n<50)	48.74

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.179	Lilliefors GOF Test
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.454	Mean in Log Scale	-2.26
SD in Original Scale	19.69	SD in Log Scale	3.839
95% t UCL (assumes normality of ROS data)	18.21	95% Percentile Bootstrap UCL	18.36
95% BCA Bootstrap UCL	25.51	95% Bootstrap t UCL	247
95% H-UCL (Log ROS)	16469143		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.713	95% H-UCL (KM -Log)	222.1
KM SD (logged)	2.162	95% Critical H Value (KM-Log)	5.526
KM Standard Error of Mean (logged)	0.715		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.492	Mean in Log Scale	-0.899
SD in Original Scale	19.67	SD in Log Scale	2.453
95% t UCL (Assumes normality)	18.24	95% H-Stat UCL	1011

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	18.73	95% KM (Percentile Bootstrap) UCL	19.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Mn in pore water from the Animas River above the confluence mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	1
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	2.57	Minimum Non-Detect	2
Maximum Detect	78300	Maximum Non-Detect	2
Variance Detects	8.44E+08	Percent Non-Detects	9.09%
Mean Detects	17912	SD Detects	29057
Median Detects	1065	CV Detects	1.622
Skewness Detects	1.611	Kurtosis Detects	1.264
Mean of Logged Detects	6.525	SD of Logged Detects	4.007

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.68	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.313	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	16284	Standard Error of Mean	8512
SD	26782	95% KM (BCA) UCL	30726
95% KM (t) UCL	31711	95% KM (Percentile Bootstrap) UCL	30586
95% KM (z) UCL	30285	95% KM Bootstrap t UCL	68468
90% KM Chebyshev UCL	41820	95% KM Chebyshev UCL	53387
97.5% KM Chebyshev UCL	69441	99% KM Chebyshev UCL	100977

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.393	Anderson-Darling GOF Test
5% A-D Critical Value	0.846	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.222	k star (bias corrected MLE)	0.222
Theta hat (MLE)	80843	Theta star (bias corrected MLE)	80771
nu hat (MLE)	4.431	nu star (bias corrected)	4.435
MLE Mean (bias corrected)	17912	MLE Sd (bias corrected)	38036

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.37	nu hat (KM)	8.133
Approximate Chi Square Value (8.13, α)	2.812	Adjusted Chi Square Value (8.13, β)	2.328
95% Gamma Approximate KM-UCL (use when n>=50)	47093	95% Gamma Adjusted KM-UCL (use when n<50)	56893

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detected data is small such as < 0.1
For such situations, GROS method tends to yield inflated values of UCLs and BTVs
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	16284
Maximum	78300	Median	590
SD	28090	CV	1.725
k hat (MLE)	0.179	k star (bias corrected MLE)	0.191
Theta hat (MLE)	91020	Theta star (bias corrected MLE)	85381
nu hat (MLE)	3.936	nu star (bias corrected)	4.196
MLE Mean (bias corrected)	16284	MLE Sd (bias corrected)	37287
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (4.20, α)	0.801	Adjusted Chi Square Value (4.20, β)	0.593
95% Gamma Approximate UCL (use when n>=50)	85346	95% Gamma Adjusted UCL (use when n<50)	115211

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.185	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	16284	Mean in Log Scale	5.649
SD in Original Scale	28090	SD in Log Scale	4.785
95% t UCL (assumes normality of ROS data)	31634	95% Percentile Bootstrap UCL	30309
95% BCA Bootstrap UCL	35146	95% Bootstrap t UCL	68483
95% H-UCL (Log ROS)	1.41E+15		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.995	95% H-UCL (KM -Log)	2.97E+11
KM SD (logged)	3.993	95% Critical H Value (KM-Log)	9.856
KM Standard Error of Mean (logged)	1.269		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	16284	Mean in Log Scale	5.932
SD in Original Scale	28090	SD in Log Scale	4.28
95% t UCL (Assumes normality)	31634	95% H-Stat UCL	5.66E+12

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	53387	95% GROS Adjusted Gamma UCL	115211
95% Adjusted Gamma KM-UCL	56893		

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL calculations for dissolved Zn in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/5/2015 14:29
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	179	Mean	5735
Maximum	29900	Median	675
SD	9691	Std. Error of Mean	2922
Coefficient of Variation	1.69	Skewness	2.038

Normal GOF Test

Shapiro Wilk Test Statistic	0.653	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.3	Lilliefors GOF Test
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	11031	95% Adjusted-CLT UCL (Chen-1995)	12459
		95% Modified-t UCL (Johnson-1978)	11330

Gamma GOF Test

A-D Test Statistic	0.829	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.791	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.271	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.447	k star (bias corrected MLE)	0.386
Theta hat (MLE)	12831	Theta star (bias corrected MLE)	14870
nu hat (MLE)	9.833	nu star (bias corrected)	8.485
MLE Mean (bias corrected)	5735	MLE Sd (bias corrected)	9234
		Approximate Chi Square Value (0.05)	3.019
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	2.512

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	16118	95% Adjusted Gamma UCL (use when n<50)	19367

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.879	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.267	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.187	Mean of logged Data	7.208
Maximum of Logged Data	10.31	SD of logged Data	1.843

Assuming Lognormal Distribution

95% H-UCL	120509	90% Chebyshev (MVUE) UCL	15021
95% Chebyshev (MVUE) UCL	19376	97.5% Chebyshev (MVUE) UCL	25421
99% Chebyshev (MVUE) UCL	37294		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	10541	95% Jackknife UCL	11031
95% Standard Bootstrap UCL	10420	95% Bootstrap-t UCL	23243
95% Hall's Bootstrap UCL	33946	95% Percentile Bootstrap UCL	10845
95% BCA Bootstrap UCL	12604		
90% Chebyshev(Mean, Sd) UCL	14500	95% Chebyshev(Mean, Sd) UCL	18471
97.5% Chebyshev(Mean, Sd) UCL	23982	99% Chebyshev(Mean, Sd) UCL	34807

Suggested UCL to Use

95% Adjusted Gamma UCL	19367

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL calculations for Hardness in pore water from the Animas River above the confluence with mainstem Cement Creek

User Selected Options	
Date/Time of Computation	3/9/2015 10:14
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

General Statistics

Total Number of Observations	11	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	118	Mean	296
Maximum	853	Median	158
SD	226.9	Std. Error of Mean	68.42
Coefficient of Variation	0.767	Skewness	1.649

Normal GOF Test

Shapiro Wilk Test Statistic	0.784	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.274	Lilliefors GOF Test
5% Lilliefors Critical Value	0.267	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	420	95% Adjusted-CLT UCL (Chen-1995)	444.9
		95% Modified-t UCL (Johnson-1978)	425.7

Gamma GOF Test

A-D Test Statistic	0.755	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.737	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.288	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.258	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.391	k star (bias corrected MLE)	1.8
Theta hat (MLE)	123.8	Theta star (bias corrected MLE)	164.5
nu hat (MLE)	52.6	nu star (bias corrected)	39.59
MLE Mean (bias corrected)	296	MLE Sd (bias corrected)	220.7
		Approximate Chi Square Value (0.05)	26.17
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	24.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	447.7	95% Adjusted Gamma UCL (use when n<50)	480.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.267	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.771	Mean of logged Data	5.467
Maximum of Logged Data	6.749	SD of logged Data	0.676

Assuming Lognormal Distribution

95% H-UCL	500	90% Chebyshev (MVUE) UCL	474.2
95% Chebyshev (MVUE) UCL	557.4	97.5% Chebyshev (MVUE) UCL	673
99% Chebyshev (MVUE) UCL	899.9		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	408.5	95% Jackknife UCL	420
95% Standard Bootstrap UCL	403.1	95% Bootstrap-t UCL	505.1
95% Hall's Bootstrap UCL	557.7	95% Percentile Bootstrap UCL	410.2
95% BCA Bootstrap UCL	439.5		
90% Chebyshev(Mean, Sd) UCL	501.3	95% Chebyshev(Mean, Sd) UCL	594.2
97.5% Chebyshev(Mean, Sd) UCL	723.3	99% Chebyshev(Mean, Sd) UCL	976.7

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	594.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Appendix 17.a: Selected HQs associated with pore water and bulk sediment from the Dec. 2012 sediment toxicity test
Baseline Ecological Risk Assessment
Upper Animas River Mining District

December 2012 *Hyalella azteca* sediment toxicity test

Sampling location	Survival[a] (mean ±SE)	Signif.?[b]	Biomass[a] (mean ±SE)	Signif.?[b]	Aluminum HQs			Arsenic HQs			Cadmium HQs			Copper HQs			Lead HQs			Manganese HQs			Zinc HQs		
					$PW_{initial}$	PW_{final}	SED[c]	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED
A56 ("upstream")	62.5±8.2%	Y	20.3±1.9 µg/org	Y	<1	--	<1	<1	--	**2.4**	<1	--	**1.9**	**1.5**	--	**2.1**	**2.7**	--	**16.2**	**2.8**	--	**5.0**	<1	--	**7.7**
A68	56.3±3.2%	Y	22.6±1.6 µg/org	Y	**1.7**	--	<1	<1	--	**2.5**	<1	--	**3.4**	**2.9**	--	**4.1**	**5.4**	--	**20.3**	**3.8**	--	**10.1**	<1	--	**16.6**
A72	36.3±4.2%	Y	16.1±1.7 µg/org	Y	<1	--	<1	<1	--	**1.4**	**1.4**	--	<1	<1	--	**1.3**	<1	--	**5.5**	**4.6**	--	**3.6**	<1	--	**2.1**
A73B	5.0±1.9%	Y	4.0±1.7 µg/org	Y	<1	--	<1	<1	--	<1	<1	--	**1.0**	<1	--	**1.6**	<1	--	**4.4**	**8.3**	--	**3.7**	<1	--	**2.7**
A75B	48.8±5.2%	Y	17.8±1.9 µg/org	Y	<1	--	<1	<1	--	**1.1**	<1	--	**2.1**	<1	--	**2.8**	<1	--	**3.4**	**5.2**	--	**3.7**	<1	--	**10.8**
Bakers Bridge	76.3±3.8%	Y	26.2±1.0 µg/org	Y	<1	--	<1	<1	--	**1.2**	<1	--	**3.4**	<1	--	**2.5**	<1	--	**3.7**	**4.0**	--	**7.3**	<1	--	**19.7**
CC49	0%	Y	no survival	Y	**12.9**	--	<1	<1	--	**2.0**	**3.1**	--	<1	**2.0**	--	<1	**3.4**	--	**1.6**	**3.2**	--	<1	**2.8**	--	<1
M34	8.8±3.5%	Y	5.1±2.0 µg/org	Y	<1	--	<1	<1	--	<1	<1	--	<1	<1	--	<1	<1	--	**1.2**	**4.6**	--	**1.0**	<1	--	<1

HQ = hazard quotient; PW = pore water; SED = sediment
note 1: the "initial" pore water samples were collected before the organisms were added to the test beakers
note 2: no "final" pore water samples were collected at the end of the test
note 3: the PW HQs were derived using dissolved metals data and the standard chronic surface water benchmarks or hardness-depedent benchmark equations presented in Table 3.1 of the BERA
[a] see Table 3.23 in the BERA
[b] is the result significantly different from the negative lab control?
[c] All the sediment HQs presented in this table were derived using the "effect" benchmarks presented in Table 3.1 of the BERA

Appendix X: Dec. 2012 Upper Animas River sediment toxicity test
Initial pore water chemistry data (dissolved metals) and chronic HQs

Sampling location	Units	Hardness (mg/L)	Initial PW Aluminum			Initial PW Arsenic			Initial PW Beryllium			Initial PW Cadmium			Initial PW Chromium			Initial PW Copper			Initial PW Iron		
			conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ
A56	ug/L	118	57.1	87	<1	1.93 J	150	<1	1.0 U	0.66	**1.5**	0.124 J	0.5	<1	0.5 U	85	<1	15.1	10	**1.5**	50 U	1000	<1
A68	ug/L	98	146	87	**1.7**	3.77	150	<1	1.0 U	0.66	**1.5**	0.123 J	0.4	<1	0.5 U	73	<1	25.6	8.8	**2.9**	50 U	1001	<1
A72	ug/L	182	27.6 J	87	<1	0.25 U	150	<1	1.0 U	0.66	**1.5**	0.931	0.7	**1.4**	0.5 U	121	<1	12.1	15	<1	50 U	1002	<1
A73B	ug/L	120	48.2 J	87	<1	0.25 U	150	<1	1.0 U	0.66	**1.5**	0.213	0.5	<1	0.5 U	86	<1	9.54	10	<1	224 J	1003	<1
A75B	ug/L	143	47.8 J	87	<1	1.14 J	150	<1	1.0 U	0.66	**1.5**	0.05 U	0.6	<1	0.5 U	99	<1	5.45	12	<1	820	1004	<1
Bbridge	ug/L	133	79.3	87	<1	0.802 J	150	<1	1.0 U	0.66	**1.5**	0.05 U	0.5	<1	0.5 U	94	<1	5.93	11	<1	169 J	1005	<1
CC-49	ug/L	161	1120	87	**12.9**	0.25 U	150	<1	1.0 U	0.66	**1.5**	1.91	0.6	**3.1**	0.5 U	109	<1	26.4	13	**2.0**	2120	1006	**2.1**
M-34	ug/L	158	38.8 J	87	<1	0.559 J	150	<1	1.0 U	0.66	**1.5**	0.412	0.6	<1	0.5 U	108	<1	6.06	13	<1	3680	1007	**3.7**

Sampling location	Units	Hardness (mg/L)	Initial PW Lead			Initial PW Manganese			Initial PW Nickel			Initial PW Selenium			Initial PW Silver			Initial PW Zinc		
			conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	benchm.	HQ	conc.	bench.	HQ	conc.	benchm.	HQ
A56	ug/L	118	8.13	3.0	**2.7**	4870	1743	**2.8**	0.663 J	60	<1	0.659 J	5.0	<1	0.25 U	0.10	**2.5**	33.5	141	<1
A68	ug/L	98	13.3	2.5	**5.4**	6180	1639	**3.8**	1.96	51	<1	0.25 U	5.0	<1	0.25 U	0.07	**3.4**	29.0	119	<1
A72	ug/L	182	0.161 J	4.8	<1	9290	2014	**4.6**	1.62	86	<1	0.775 J	5.0	<1	0.25 U	0.21	**1.2**	27.5	209	<1
A73B	ug/L	120	0.5 U	3.1	<1	14500	1753	**8.3**	1.27	61	<1	1.13	5.0	<1	0.25 U	0.10	**2.4**	27.6	143	<1
A75B	ug/L	143	0.165 J	3.7	<1	9630	1858	**5.2**	0.662 J	70	<1	1.57	5.0	<1	0.25 U	0.14	**1.8**	26.1	168	<1
Bbridge	ug/L	133	0.14 J	3.4	<1	7320	1814	**4.0**	0.545 J	66	<1	0.977 J	5.0	<1	0.25 U	0.12	**2.0**	38.0	157	<1
CC-49	ug/L	161	14.5	4.2	**3.4**	6180	1933	**3.2**	5.67	78	<1	0.879 J	5.0	<1	0.25 U	0.17	**1.5**	516	187	**2.8**
M-34	ug/L	158	0.168 J	4.1	<1	8920	1921	**4.6**	2.68	77	<1	1.53	5.0	<1	0.25 U	0.16	**1.5**	37.9	184	<1

note 1: the "initial" pore water samples were collected before the organisms were added to the test beakers
note 2: no "final" pore water samples were collected at the end of the test

Appendix X: December 2012 Upper Animas River sediment toxicity test
Sediment analytical chemistry and hazard quotients

Sampling location	Units	Aluminum						Arsenic						Beryllium						Cadmium					
		conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ
A56	mg/kg dw	9790	D	26000	60000	<1	<1	79.6	D	9.8	33	8.1	**2.4**	2.76	JD	not avail.	not avail.	--	--	9.22	BD	0.99	4.98	9.3	**1.9**
A68	mg/kg dw	14500	D	26000	60000	<1	<1	82.4	D	9.8	33	8.4	**2.5**	5.14	D	not avail.	not avail.	--	--	16.7	BD	0.99	4.98	16.9	**3.4**
A72	mg/kg dw	24800	D	26000	60000	1.0	<1	45.6	D	9.8	33	4.7	**1.4**	1.0	U	not avail.	not avail.	--	--	3.28	BD	0.99	4.98	3.3	<1
A73B	mg/kg dw	17200	D	26000	60000	<1	<1	29.1	D	9.8	33	3.0	<1	1.0	U	not avail.	not avail.	--	--	5.22	BD	0.99	4.98	5.3	**1.0**
A75B	mg/kg dw	47400	D	26000	60000	1.8	<1	37.5	D	9.8	33	3.8	**1.1**	5.63	D	not avail.	not avail.	--	--	10.3	BD	0.99	4.98	10.4	**2.1**
Bbridge	mg/kg dw	44800	D	26000	60000	1.7	<1	40.2	D	9.8	33	4.1	**1.2**	5.72	D	not avail.	not avail.	--	--	16.9	BD	0.99	4.98	17.1	**3.4**
CC-49	mg/kg dw	4140	D	26000	60000	<1	<1	66.7	D	9.8	33	6.8	**2.0**	0.98	U	not avail.	not avail.	--	--	0.34	BD	0.99	4.98	<1	<1
M-34	mg/kg dw	32800	D	26000	60000	1.3	<1	21	D	9.8	33	2.1	<1	0.98	U	not avail.	not avail.	--	--	1.06	BD	0.99	4.98	1.1	<1

Sampling location	Units	Chromium						Copper						Iron					
		conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ
A56	mg/kg dw	5.48	D	43.4	111	<1	<1	306	D	31.6	149	9.7	**2.1**	28700	D	190000	250000	<1	<1
A68	mg/kg dw	8.8	D	43.4	111	<1	<1	605	D	31.6	149	19.1	**4.1**	43900	D	190000	250000	<1	<1
A72	mg/kg dw	4.66	D	43.4	111	<1	<1	198	D	31.6	149	6.3	**1.3**	60600	D	190000	250000	<1	<1
A73B	mg/kg dw	4.7	D	43.4	111	<1	<1	232	D	31.6	149	7.3	**1.6**	48500	D	190000	250000	<1	<1
A75B	mg/kg dw	5.42	D	43.4	111	<1	<1	415	D	31.6	149	13.1	**2.8**	81400	D	190000	250000	<1	<1
Bbridge	mg/kg dw	5.26	D	43.4	111	<1	<1	377	D	31.6	149	11.9	**2.5**	78500	D	190000	250000	<1	<1
CC-49	mg/kg dw	4.71	D	43.4	111	<1	<1	57.8	D	31.6	149	1.8	<1	3E+05	D	190000	250000	1.5	**1.2**
M-34	mg/kg dw	3.64	D	43.4	111	<1	<1	91.4	D	31.6	149	2.9	<1	62300	D	190000	250000	<1	<1

Sampling location	Units	Lead						Manganese						Nickel					
		conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm	E benchm.	NE HQ	E HQ
A56	mg/kg dw	2070	D	35.8	128	57.8	**16.2**	6020	D	630	1200	9.6	**5.0**	8.58	D	22.7	48.6	<1	<1
A68	mg/kg dw	2600	D	35.8	128	72.6	**20.3**	12100	D	630	1200	19.2	**10.1**	15.2	D	22.7	48.6	<1	<1
A72	mg/kg dw	704	D	35.8	128	19.7	**5.5**	4320	D	630	1200	6.9	**3.6**	7.18	D	22.7	48.6	<1	<1
A73B	mg/kg dw	557	D	35.8	128	15.6	**4.4**	4430	D	630	1200	7.0	**3.7**	11.5	D	22.7	48.6	<1	<1
A75B	mg/kg dw	436	D	35.8	128	12.2	**3.4**	4440	D	630	1200	7.0	**3.7**	16.1	D	22.7	48.6	<1	<1
Bbridge	mg/kg dw	471	D	35.8	128	13.2	**3.7**	8790	D	630	1200	14.0	**7.3**	31	D	22.7	48.6	1.4	<1
CC-49	mg/kg dw	206	D	35.8	128	5.8	**1.6**	307	D	630	1200	<1	<1	1.89	D	22.7	48.6	<1	<1
M-34	mg/kg dw	152	D	35.8	128	4.2	**1.2**	1220	D	630	1200	1.9	**1.0**	4.52	D	22.7	48.6	<1	<1

Sampling location	Units	Selenium						Silver						Zinc					
		conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ	conc.		NE benchm.	E benchm.	NE HQ	E HQ
A56	mg/kg dw	0.26	U	0.9	4.7	<1	<1	10.3	D	1.0	3.7	10.3	**2.8**	3530	D	121	459	29.2	**7.7**
A68	mg/kg dw	1.22	D	0.9	4.7	1.4	<1	12	D	1.0	3.7	12.0	**3.2**	7630	D	121	459	63.1	**16.6**
A72	mg/kg dw	0.25	U	0.9	4.7	<1	<1	3.53	D	1.0	3.7	3.5	**1.0**	968	D	121	459	8.0	**2.1**
A73B	mg/kg dw	0.25	U	0.9	4.7	<1	<1	3.29	D	1.0	3.7	3.3	<1	1240	D	121	459	10.2	**2.7**
A75B	mg/kg dw	1.11	D	0.9	4.7	1.2	<1	2.07	D	1.0	3.7	2.1	<1	4980	D	121	459	41.2	**10.8**
Bbridge	mg/kg dw	0.25	U	0.9	4.7	<1	<1	2.2	D	1.0	3.7	2.2	<1	9060	D	121	459	74.9	**19.7**
CC-49	mg/kg dw	0.45	U	0.9	4.7	<1	<1	1.2	D	1.0	3.7	1.2	<1	132	D	121	459	1.1	<1
M-34	mg/kg dw	0.45	U	0.9	4.7	<1	<1	0.56	JD	1.0	3.7	<1	<1	323	D	121	459	2.7	<1

Appendix 17.b: Selected HQs associated with pore water and bulk sediment from the November 2014 sediment toxicity test
Baseline Ecological Risk Assessment
Upper Animas River Mining District

November 2014 *Hyalella azteca* sediment toxicity test

Sampling location	Survival[a] (mean ±SE)	Signif.?[b]	Biomass[a] (mean±SE)	Signif.?[b]	Aluminum HQs			Arsenic HQs			Cadmium HQs			Copper HQs			Lead HQs			Manganese HQs			Zinc HQs		
					$PW_{initial}$	PW_{final}	SED[c]	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED	$PW_{initial}$	PW_{final}	SED
A56 ("upstream")	43.8±9.2%	Y	14.3±3.2 µg/g	Y	**1.6**	<1	<1	<1	<1	<1	**2.7**	**2.3**	**2.3**	**5.2**	**4.5**	**1.6**	**2.2**	**3.0**	**9.2**	**6.3**	**4.8**	**7.7**	**1.1**	<1	**7.0**
A60	77.5±6.5%	N	23.1±1.9 µg/g	Y	<1	<1	<1	<1	<1	<1	**10.4**	**14.1**	**1.9**	**1.0**	<1	**1.8**	<1	<1	**12.6**	**1.8**	**5.1**	**6.2**	**2.9**	**3.8**	**4.6**
A68	70.0±10.0%	N	23.2±3.3 µg/g	Y	<1	<1	<1	<1	<1	<1	**2.1**	**2.3**	**2.2**	<1	<1	**1.4**	<1	<1	**9.7**	<1	<1	**7.9**	**1.2**	**1.2**	**5.4**
A72	70.0±4.6%	N	27.9±2.4 µg/g	Y	<1	<1	<1	<1	<1	<1	**4.4**	**3.4**	<1	<1	<1	<1	<1	<1	**3.9**	**1.8**	**6.1**	**2.8**	**1.1**	<1	**1.9**
A73	73.8±7.8%	N	21.2±2.4 µg/g	Y	<1	<1	<1	<1	<1	<1	**1.3**	**1.9**	<1	**1.2**	<1	<1	<1	<1	**3.4**	<1	<1	**2.3**	**1.5**	**1.9**	**1.6**
A75D	76.3±7.5%	N	24.9±3.2 µg/g	Y	<1	<1	<1	<1	<1	<1	**3.2**	**3.3**	<1	<1	<1	<1	<1	<1	**2.6**	**1.3**	**1.7**	**3.1**	**1.0**	**1.1**	**2.4**
Bakers Bridge	86.3±3.8%	N	30.7±2.2 µg/g	Y	**1.6**	<1	<1	<1	<1	<1	**2.4**	<1	<1	<1	<1	<1	<1	<1	**1.9**	**2.3**	**2.5**	**3.3**	<1	<1	**3.7**

HQ = hazard quotient; PW = pore water; SED = sediment
note 1: the "initial" pore water samples were collected before the organisms were added to the test beakers
note 2: the "final" pore water samples were collected at the end of the test
note 3: the PW HQs were derived using dissolved metals data and the standard chronic surface water benchmarks or hardness-depedent benchmark equations presented in Table 3.1 of the BERA
[a] see Table 3.23 in the BERA
[b] is the result significantly different from the negative lab control?
[c] All the sediment HQs presented in this table were derived using the "effect" benchmarks presented in Table 3.1 of the BERA

Samplinglocation	Analysis	Units	Hardness	initial PW Aluminum				Initial PW Arsenic				initial PW Beryllium				initial PW Cadmium			
				conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	DissolvedMetals	ug/L	155	136		87	**1.6**	1.5	J	150	<1	1.0	U	0.66	**1.5**	1.62		0.59	**2.7**
A60	DissolvedMetals	ug/L	174	32.4	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	6.69		0.64	**10.4**
A68	DissolvedMetals	ug/L	155	29.05		87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	1.216		0.59	**2.1**
A72	DissolvedMetals	ug/L	143	23.9	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	2.46		0.56	**4.4**
A73	DissolvedMetals	ug/L	120	24.4	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	0.634		0.49	**1.3**
A75D	DissolvedMetals	ug/L	127	28	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	1.62		0.51	**3.2**
Bakers Bridge	DissolvedMetals	ug/L	145	138		87	**1.6**	0.665	J	150	<1	1.0	U	0.66	**1.5**	1.35		0.56	**2.4**

Samplinglocation	initial PW Chromium				initial PW Copper				initial PW Iron				initial PW Lead				initial PW Manganese			
	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	1.11	J	106	<1	67.5		13	**5.2**	50	U	1000	<1	8.72		4.0	**2.2**	12100		1909	**6.3**
A60	1.27	J	117	<1	14.7		14	**1.0**	50	U	1000	<1	2.41		4.6	<1	3520		1984	**1.8**
A68	0.5	U	106	<1	4.37		13	<1	50	U	1000	<1	0.473		4.0	<1	295		1909	<1
A72	0.5	U	99	<1	3.37		12	<1	50	U	1000	<1	0.191	J	3.7	<1	3430		1858	**1.8**
A73	0.5	U	86	<1	12.8		10	**1.2**	50	U	1000	<1	0.799		3.1	<1	55.4		1753	<1
A75D	0.5	U	90	<1	4.05		11	<1	50	U	1000	<1	0.299		3.3	<1	2320		1786	**1.3**
Bakers Bridge	0.5	U	100	<1	7.82		12	<1	50	U	1000	<1	0.632		3.8	<1	4280		1867	**2.3**

Samplinglocation	initial PW Nickel				initial PW Selenium				initial PW Silver				initial PW Zinc			
	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	1.13		75	<1	1.17	J	4.6	<1	0.636	J	0.16	**4.0**	190		181	**1.1**
A60	1.05		83	<1	0.5	U	4.6	<1	0.25	U	0.19	**1.3**	588		201	**2.9**
A68	0.25	U	75	<1	0.5	U	4.6	<1	0.25	U	0.16	**1.6**	213		181	**1.2**
A72	1.49		70	<1	0.5	U	4.6	<1	0.25	U	0.14	**1.8**	182		168	**1.1**
A73	1.04		61	<1	0.5	U	4.6	<1	0.25	U	0.10	**2.4**	220		143	**1.5**
A75D	0.716	J	64	<1	0.5	U	4.6	<1	0.25	U	0.11	**2.2**	157		151	**1.0**
Bakers Bridge	1.16		71	<1	0.5	U	4.6	<1	0.25	U	0.14	**1.8**	67.8		170	<1

note 1: a non detect value is shown at half of its detection limit

Samplinglocation	Analysis	Units	Hardness	initial PW Aluminum conc.		benchm.	HQ	Initial PW Arsenic conc.		benchm.	HQ	initial PW Beryllium conc.		benchm.	HQ	initial PW Cadmium conc.		benchm.	HQ
A56	DissolvedMetals	ug/L	155	136		87	**1.6**	1.5	J	150	<1	1.0	U	0.66	**1.5**	1.62		0.59	**2.7**
A60	DissolvedMetals	ug/L	174	32.4	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	6.69		0.64	**10.4**
A68	DissolvedMetals	ug/L	155	29.05		87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	1.216		0.59	**2.1**
A72	DissolvedMetals	ug/L	143	23.9	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	2.46		0.56	**4.4**
A73	DissolvedMetals	ug/L	120	24.4	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	0.634		0.49	**1.3**
A75D	DissolvedMetals	ug/L	127	28	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**	1.62		0.51	**3.2**
Bbridge	DissolvedMetals	ug/L	145	138		87	**1.6**	0.665	J	150	<1	1.0	U	0.66	**1.5**	1.35		0.56	**2.4**

Samplinglocation	initial PW Chromium conc.		benchm.	HQ	initial PW Copper conc.		benchm.	HQ	initial PW Iron conc.		benchm.	HQ	initial PW Lead conc.		benchm.	HQ
A56	1.11	J	106	<1	67.5		13	**5.2**	50	U	1000	<1	8.72		4.0	**2.2**
A60	1.27	J	117	<1	14.7		14	**1.0**	50	U	1000	<1	2.41		4.6	<1
A68	0.5	U	106	<1	4.37		13	<1	50	U	1000	<1	0.473		4.0	<1
A72	0.5	U	99	<1	3.37		12	<1	50	U	1000	<1	0.191	J	3.7	<1
A73	0.5	U	86	<1	12.8		10	**1.2**	50	U	1000	<1	0.799		3.1	<1
A75D	0.5	U	90	<1	4.05		11	<1	50	U	1000	<1	0.299		3.3	<1
Bbridge	0.5	U	100	<1	7.82		12	<1	50	U	1000	<1	0.632		3.8	<1

Samplinglocation	initial PW Manganese conc.		benchm.	HQ	initial PW Nickel conc.		benchm.	HQ	initial PW Selenium conc.		benchm.	HQ	initial PW Silver conc.		benchm.	HQ	initial PW Zinc conc.		benchm.	HQ
A56	12100		1909	**6.3**	1.13		75	<1	1.17	J	4.6	<1	0.636	J	0.16	**4.0**	190		181	**1.1**
A60	3520		1984	**1.8**	1.05		83	<1	0.5	U	4.6	<1	0.25	U	0.19	**1.3**	588		201	**2.9**
A68	295		1909	<1	0.25	U	75	<1	0.5	U	4.6	<1	0.25	U	0.16	**1.6**	213		181	**1.2**
A72	3430		1858	**1.8**	1.49		70	<1	0.5	U	4.6	<1	0.25	U	0.14	**1.8**	182		168	**1.1**
A73	55.4		1753	<1	1.04		61	<1	0.5	U	4.6	<1	0.25	U	0.10	**2.4**	220		143	**1.5**
A75D	2320		1786	**1.3**	0.716	J	64	<1	0.5	U	4.6	<1	0.25	U	0.11	**2.2**	157		151	**1.0**
Bbridge	4280		1867	**2.3**	1.16		71	<1	0.5	U	4.6	<1	0.25	U	0.14	**1.8**	67.8		170	<1

note 1: a non detect value is shown at half of its detection limit

Sampling Station	Analysis	Units	Hardness	final PW Aluminum				final PW Arsenic				final PW Beryllium			
				conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	DissolvedMetals	ug/L	114	64.5		87	<1	1.03	J	150	<1	1.0	U	0.66	**1.5**
A60	DissolvedMetals	ug/L	263	37.4	J	87	<1	1.03	J	150	<1	1.0	U	0.66	**1.5**
A68	DissolvedMetals	ug/L	174	21.5	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**
A72	DissolvedMetals	ug/L	218	37.7	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**
A73	DissolvedMetals	ug/L	131	21.1	J	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**
A75D	DissolvedMetals	ug/L	155	10	U	87	<1	0.25	U	150	<1	1.0	U	0.66	**1.5**
Bakers Bridge	DissolvedMetals	ug/L	182	72.4		87	<1	1.01	J	150	<1	1.0	U	0.66	**1.5**

Sampling Station	final PW Cadmium				final PW Chromium				final PW Copper				final PW Iron			
	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	1.08		0.47	**2.3**	1.82	J	83	<1	45.5		10	**4.5**	50	U	1000	<1
A60	12.4		0.88	**14.1**	3.11		164	<1	11.7		20	<1	50	U	1000	<1
A68	1.51		0.64	**2.3**	1.79	J	117	<1	4.51		14	<1	50	U	1000	<1
A72	2.58		0.76	**3.4**	0.5	U	140	<1	3.38		17	<1	281		1000	<1
A73	0.968		0.52	**1.9**	0.5	U	92	<1	2.36		11	<1	50	U	1000	<1
A75D	1.97		0.59	**3.3**	0.5	U	106	<1	4.26		13	<1	50	U	1000	<1
Bakers Bridge	0.479		0.67	<1	0.5	U	121	<1	8.89		15	<1	50	U	1000	<1

Sampling Station	final PW Lead				final PW Manganese				final PW Nickel			
	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	8.78		2.9	**3.0**	8210		1723	**4.8**	0.25	U	58	<1
A60	2.51		7.1	<1	11700		2276	**5.1**	0.25	U	118	<1
A68	0.160		4.6	<1	520		1984	<1	0.25	U	83	<1
A72	0.1	U	5.8	<1	13100		2139	**6.1**	0.25	U	101	<1
A73	0.17	J	3.4	<1	158		1805	<1	1.59		65	<1
A75D	0.137	J	4.0	<1	3150		1909	**1.7**	0.25	U	75	<1
Bakers Bridge	1.31		4.8	<1	4970		2014	**2.5**	0.25	U	86	<1

Sampling Station	final PW Selenium				final PW Silver				final PW Zinc			
	conc.		benchm.	HQ	conc.		benchm.	HQ	conc.		benchm.	HQ
A56	1.07	J	4.6	<1	0.25	U	0.09	**2.7**	60.7		137	<1
A60	1.03	J	4.6	<1	0.25	U	0.40	<1	1100		292	**3.8**
A68	0.5	U	4.6	<1	0.25	U	0.19	**1.3**	243		201	**1.2**
A72	0.5	U	4.6	<1	0.25	U	0.29	<1	217		246	<1
A73	0.5	U	4.6	<1	0.25	U	0.12	**2.1**	298		155	**1.9**
A75D	0.5	U	4.6	<1	0.25	U	0.16	**1.6**	191		181	**1.1**
Bakers Bridge	1.47	J	4.6	<1	0.25	U	0.21	**1.2**	32.7		209	<1

note 1: a non detect value is shown at half of its detection limit

Station ID		Aluminum						Arsenic						Beryllium						Cadmium						Chromium						Copper						Iron						Lead						Manganese						Mercury						Nickel						Selenium						Silver						Zinc					
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